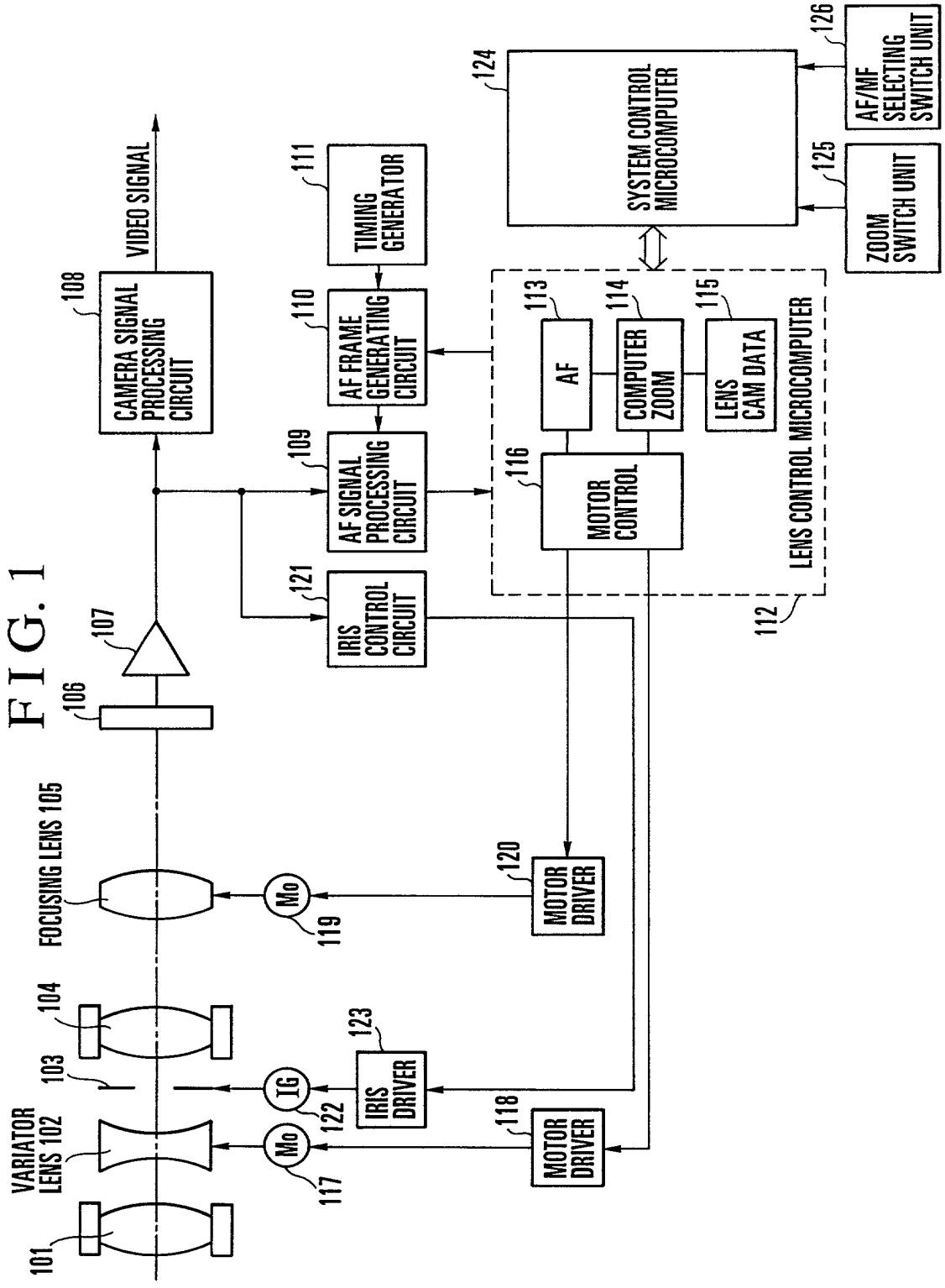

101
VARIATOR LENS 102
103
104
FOCUSING LENS 105
106
107
108
CAMERA SIGNAL PROCESSING CIRCUIT
VIDEO SIGNAL
109
AF SIGNAL PROCESSING CIRCUIT
110
AF FRAME GENERATING CIRCUIT
111
TIMING GENERATOR
112
LENS CONTROL MICROCOMPUTER
113
AF
114
COMPUTER ZOOM
115
LENS CAM DATA
116
MOTOR CONTROL
117
Mo
118
MOTOR DRIVER
119
Mo
120
MOTOR DRIVER
121
IRIS CONTROL CIRCUIT
122
IG
123
IRIS DRIVER
124
SYSTEM CONTROL MICROCOMPUTER
125
ZOOM SWITCH UNIT
126
AF/MF SELECTING SWITCH UNIT

FIG. 1

FIG. 2

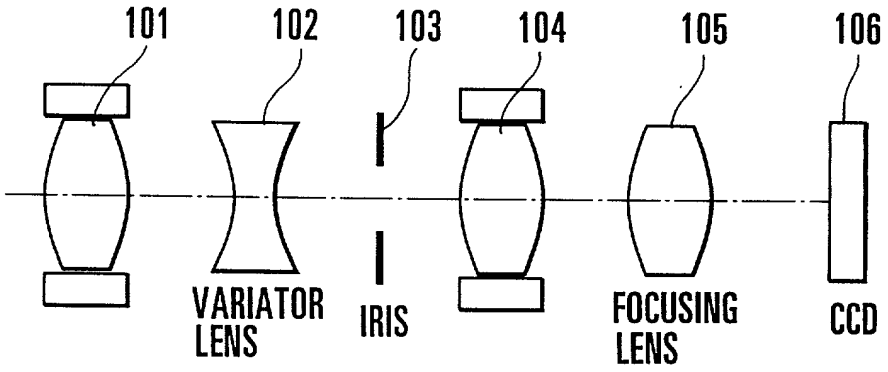

101
102
103
104
105
106
VARIATOR LENS
IRIS
FOCUSING LENS
CCD

FIG. 3

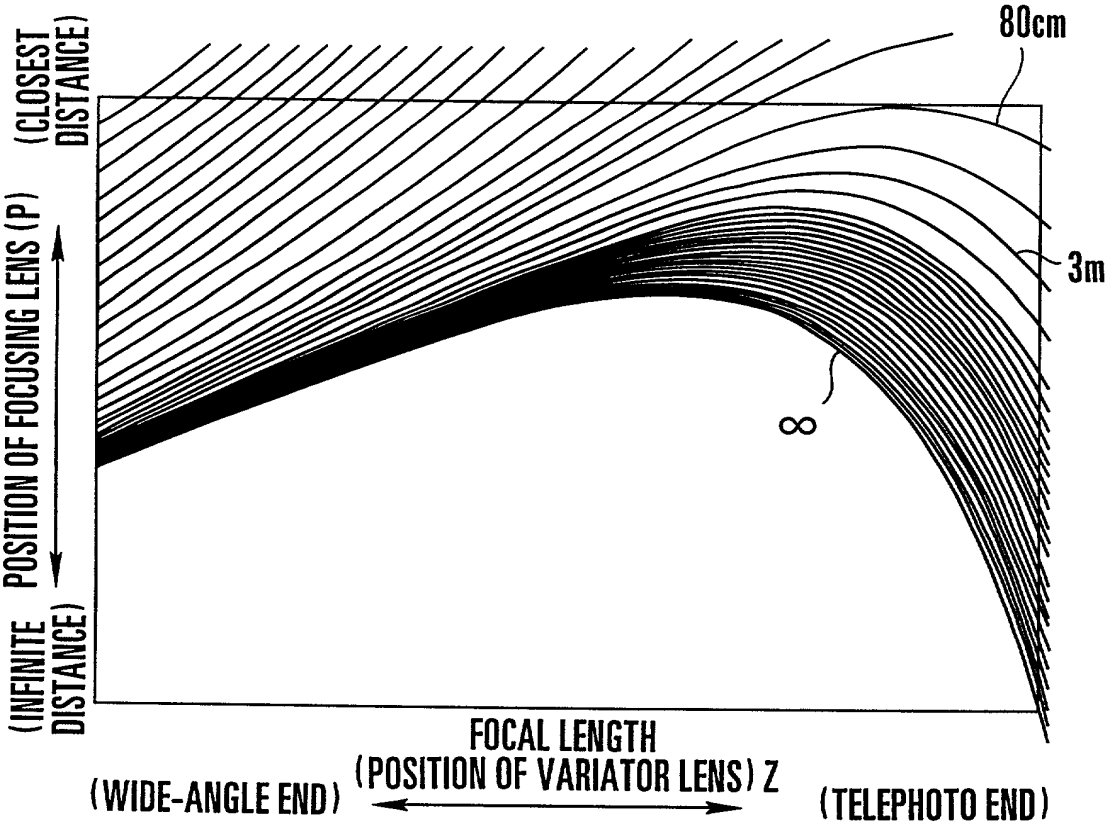

80cm
3m
∞
(CLOSEST DISTANCE)
POSITION OF FOCUSING LENS (P)
(INFINITE DISTANCE)
FOCAL LENGTH
(POSITION OF VARIATOR LENS) Z
(WIDE-ANGLE END)
(TELEPHOTO END)

FIG. 4

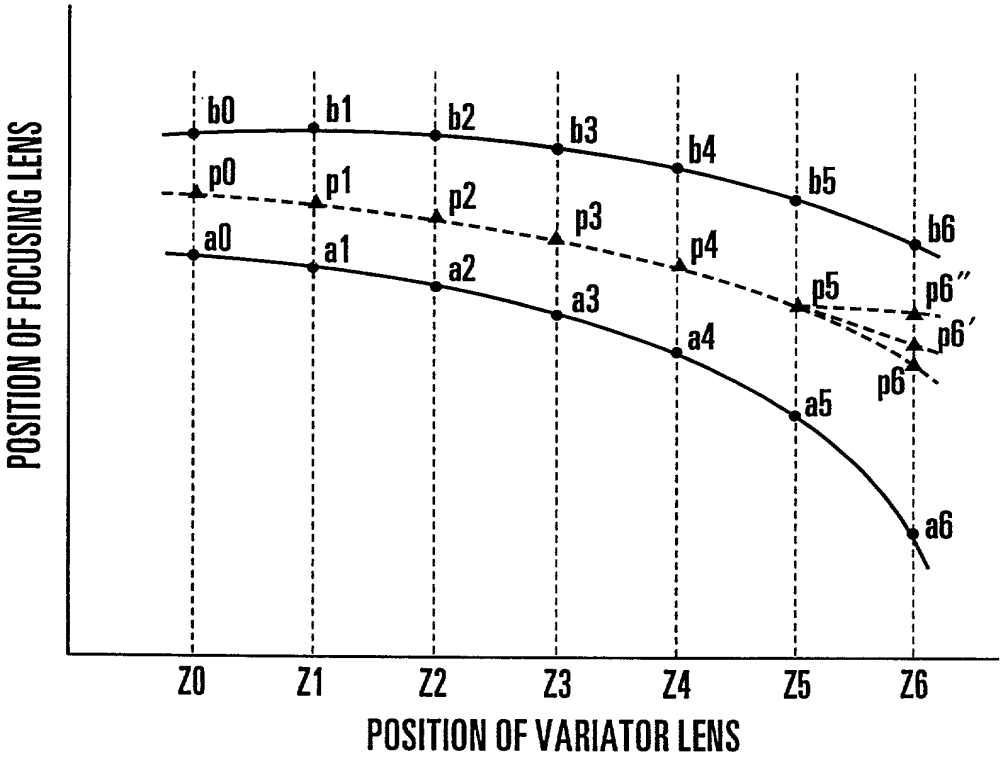
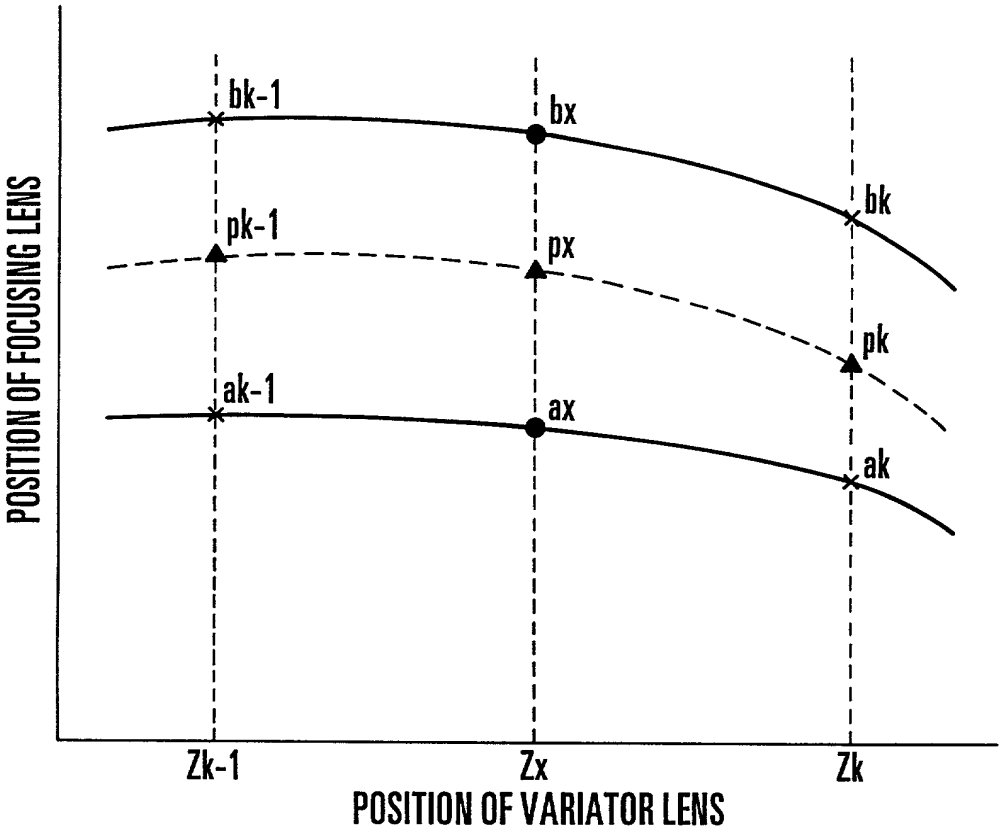

POSITION OF FOCUSING LENS
b0
b1
b2
b3
b4
b5
b6
p0
p1
p2
p3
p4
p5
p6″
p6′
p6
a0
a1
a2
a3
a4
a5
a6
Z0
Z1
Z2
Z3
Z4
Z5
Z6
POSITION OF VARIATOR LENS

FIG. 5



$$ax = ak - \frac{(Zk - Zx)(ak - ak\text{-}1)}{(Zk - Zk\text{-}1)}$$

$$bx = bk - \frac{(Zk - Zx)(bk - bk\text{-}1)}{(Zk - Zk\text{-}1)}$$

TOSHIBA 2562860

FIG. 6(A)

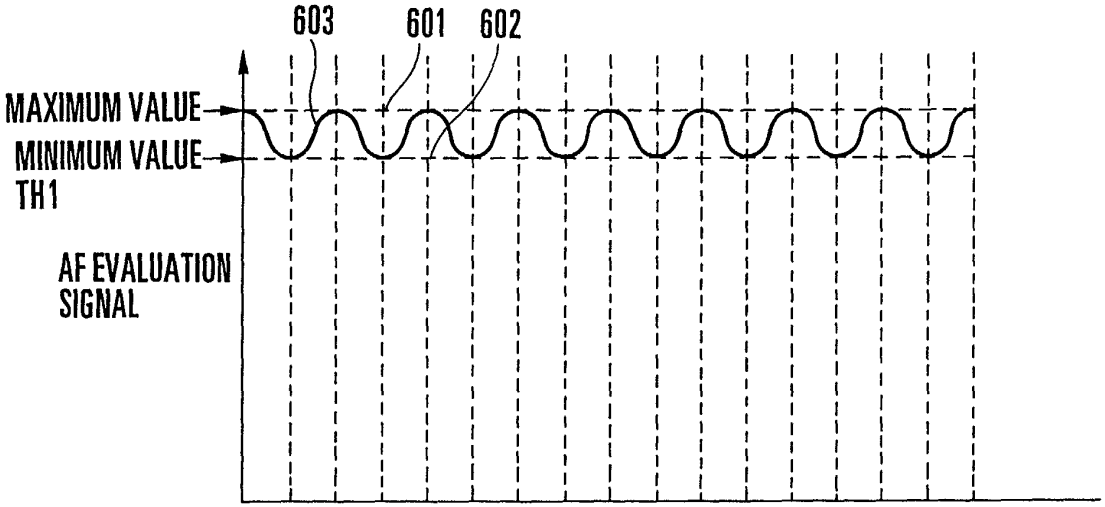


FIG. 6(B)

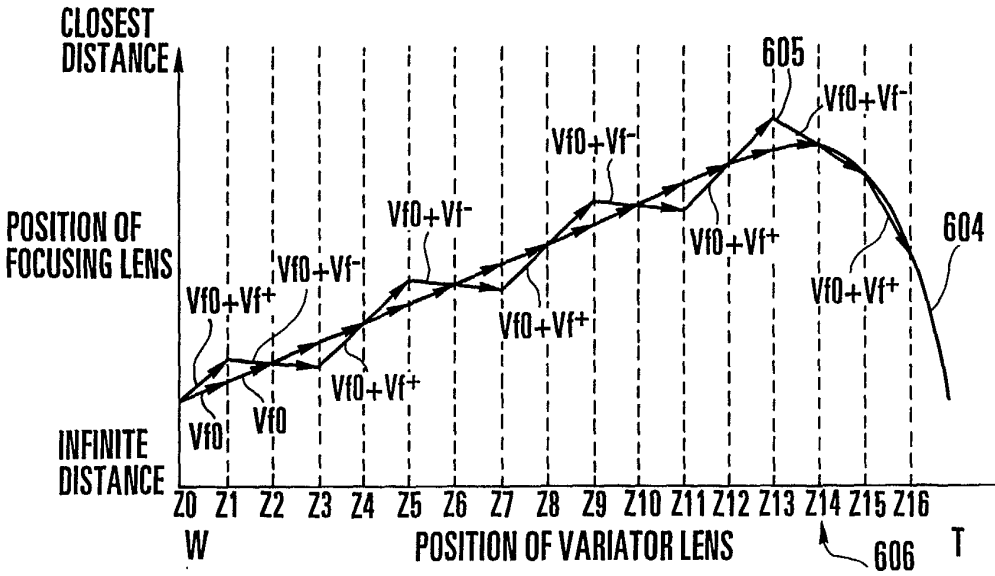


FIG. 7

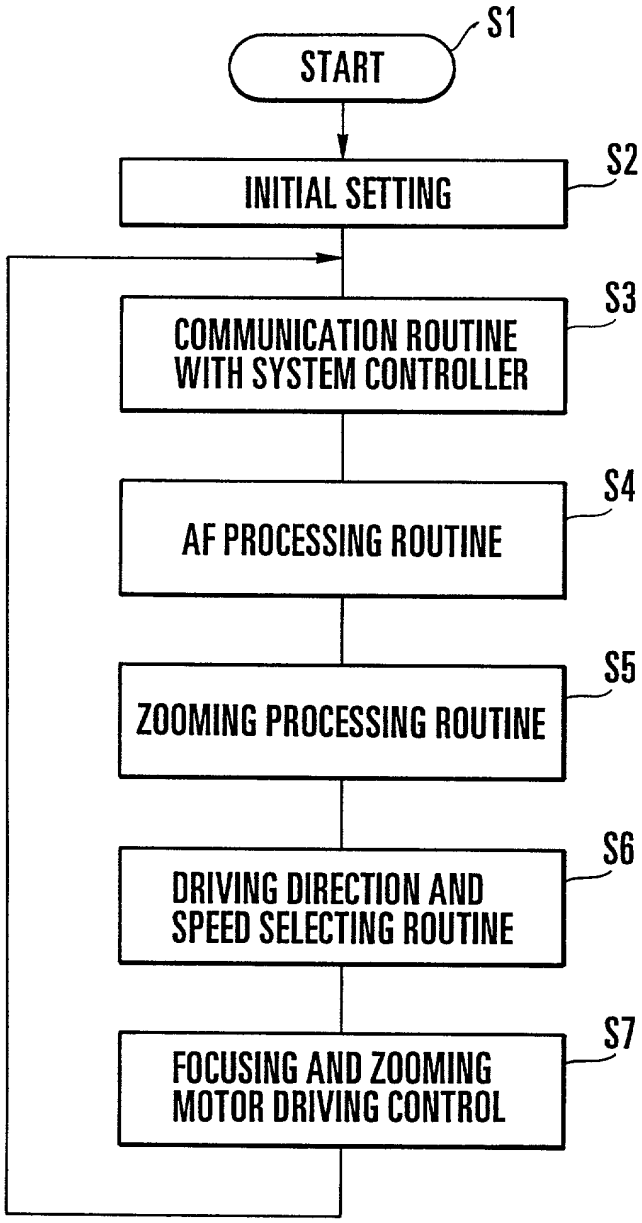

S1
START
INITIAL SETTING
S2
COMMUNICATION ROUTINE WITH SYSTEM CONTROLLER
S3
AF PROCESSING ROUTINE
S4
ZOOMING PROCESSING ROUTINE
S5
DRIVING DIRECTION AND SPEED SELECTING ROUTINE
S6
FOCUSING AND ZOOMING MOTOR DRIVING CONTROL
S7

FIG. 8

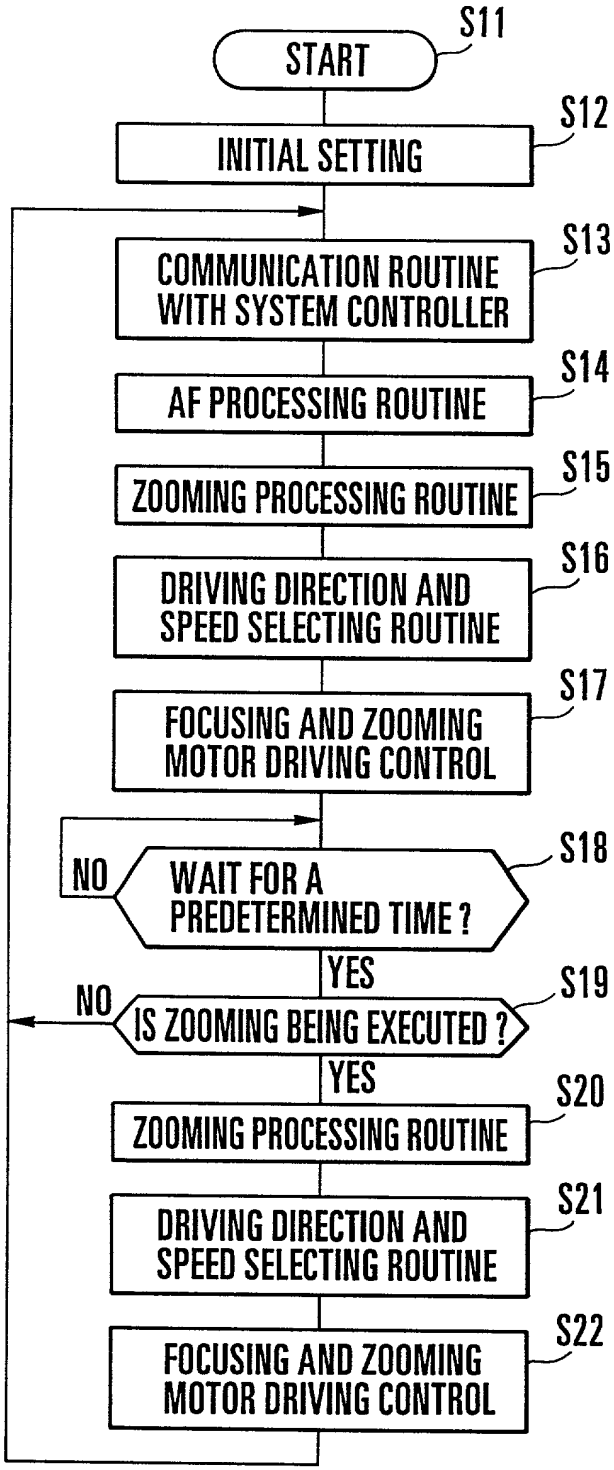

S11
START
S12
INITIAL SETTING
S13
COMMUNICATION ROUTINE WITH SYSTEM CONTROLLER
S14
AF PROCESSING ROUTINE
S15
ZOOMING PROCESSING ROUTINE
S16
DRIVING DIRECTION AND SPEED SELECTING ROUTINE
S17
FOCUSING AND ZOOMING MOTOR DRIVING CONTROL
S18
NO
WAIT FOR A PREDETERMINED TIME ?
YES
S19
NO
IS ZOOMING BEING EXECUTED ?
YES
S20
ZOOMING PROCESSING ROUTINE
S21
DRIVING DIRECTION AND SPEED SELECTING ROUTINE
S22
FOCUSING AND ZOOMING MOTOR DRIVING CONTROL

FIG. 9

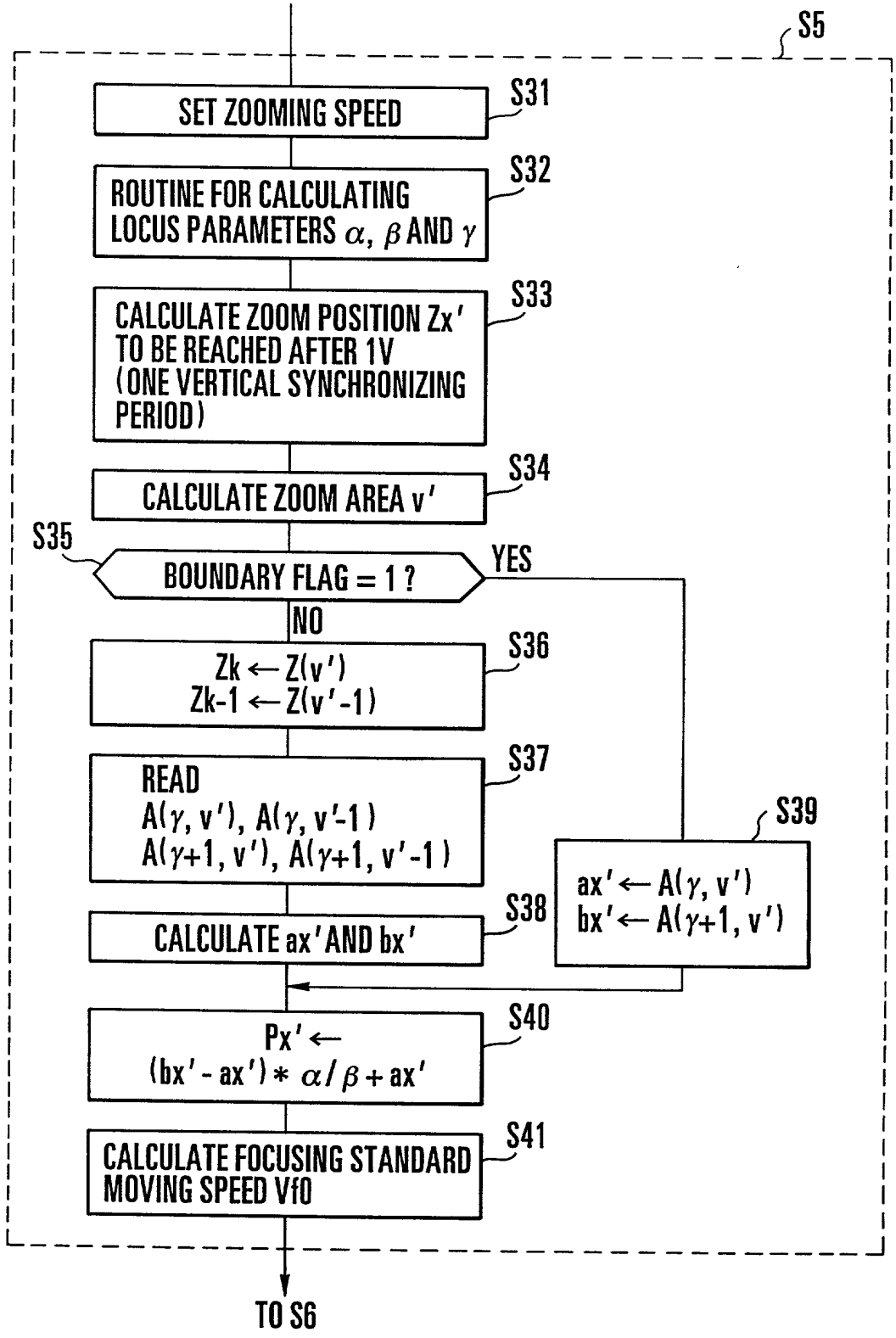

S5
SET ZOOMING SPEED
S31
ROUTINE FOR CALCULATING LOCUS PARAMETERS α, β AND γ
S32
CALCULATE ZOOM POSITION Zx' TO BE REACHED AFTER 1V (ONE VERTICAL SYNCHRONIZING PERIOD)
S33
CALCULATE ZOOM AREA v'
S34
S35
BOUNDARY FLAG = 1 ?
YES
NO
Zk ← Z(v')
Zk-1 ← Z(v'-1)
S36
READ
A(γ, v'), A(γ, v'-1)
A(γ+1, v'), A(γ+1, v'-1)
S37
S39
ax' ← A(γ, v')
bx' ← A(γ+1, v')
CALCULATE ax' AND bx'
S38
Px' ←
(bx' - ax') * α/β + ax'
S40
CALCULATE FOCUSING STANDARD MOVING SPEED Vf0
S41
TO S6

FIG. 10

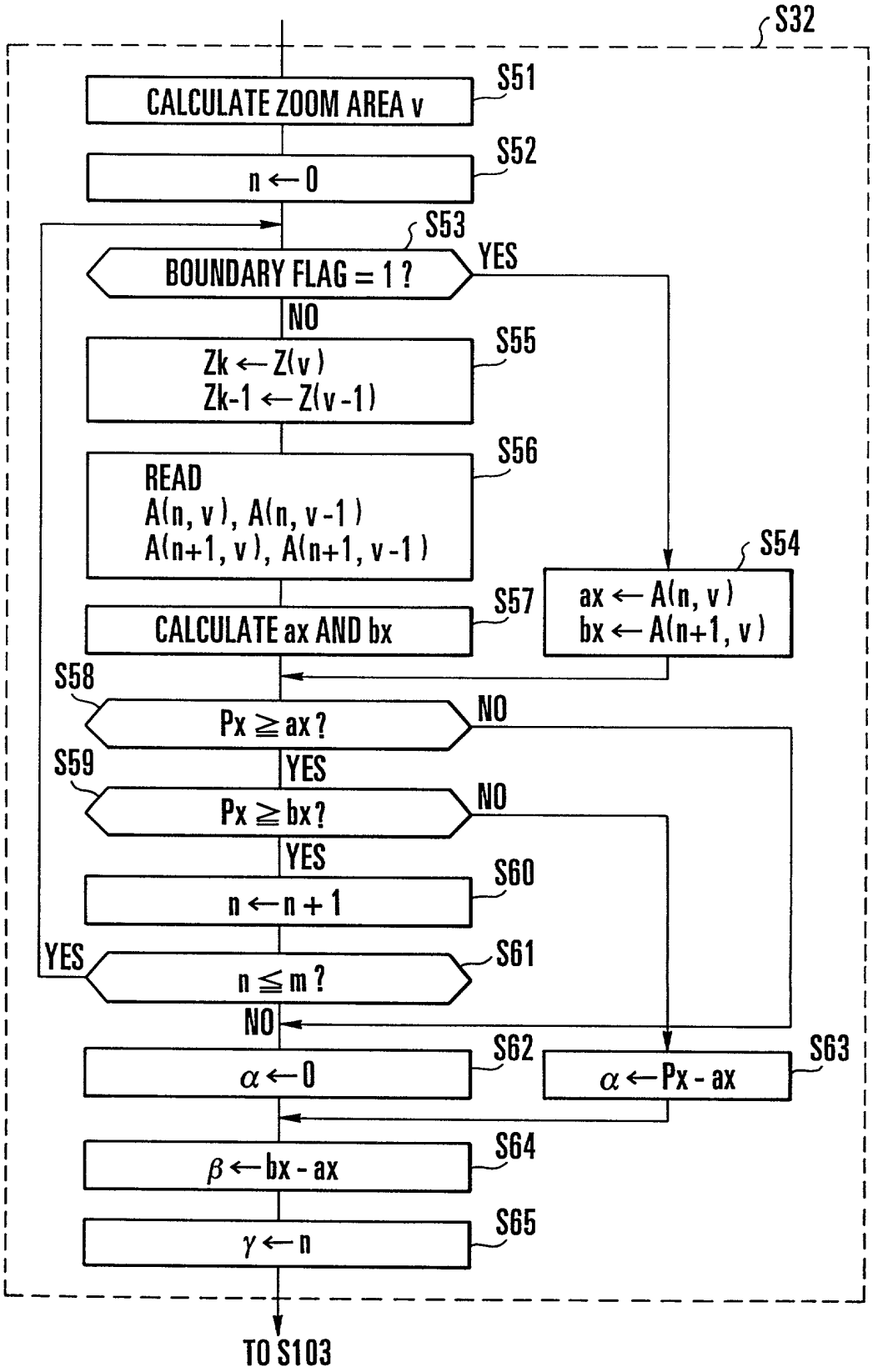

S32
CALCULATE ZOOM AREA v
S51
n ← 0
S52
S53
BOUNDARY FLAG = 1 ?
YES
NO
Zk ← Z(v)
Zk-1 ← Z(v-1)
S55
READ
A(n, v), A(n, v-1)
A(n+1, v), A(n+1, v-1)
S56
S54
ax ← A(n, v)
bx ← A(n+1, v)
CALCULATE ax AND bx
S57
S58
Px ≧ ax ?
NO
S59
YES
Px ≧ bx ?
NO
YES
n ← n + 1
S60
YES
n ≦ m ?
S61
NO
α ← 0
S62
α ← Px - ax
S63
β ← bx - ax
S64
γ ← n
S65
TO S103

FIG. 11

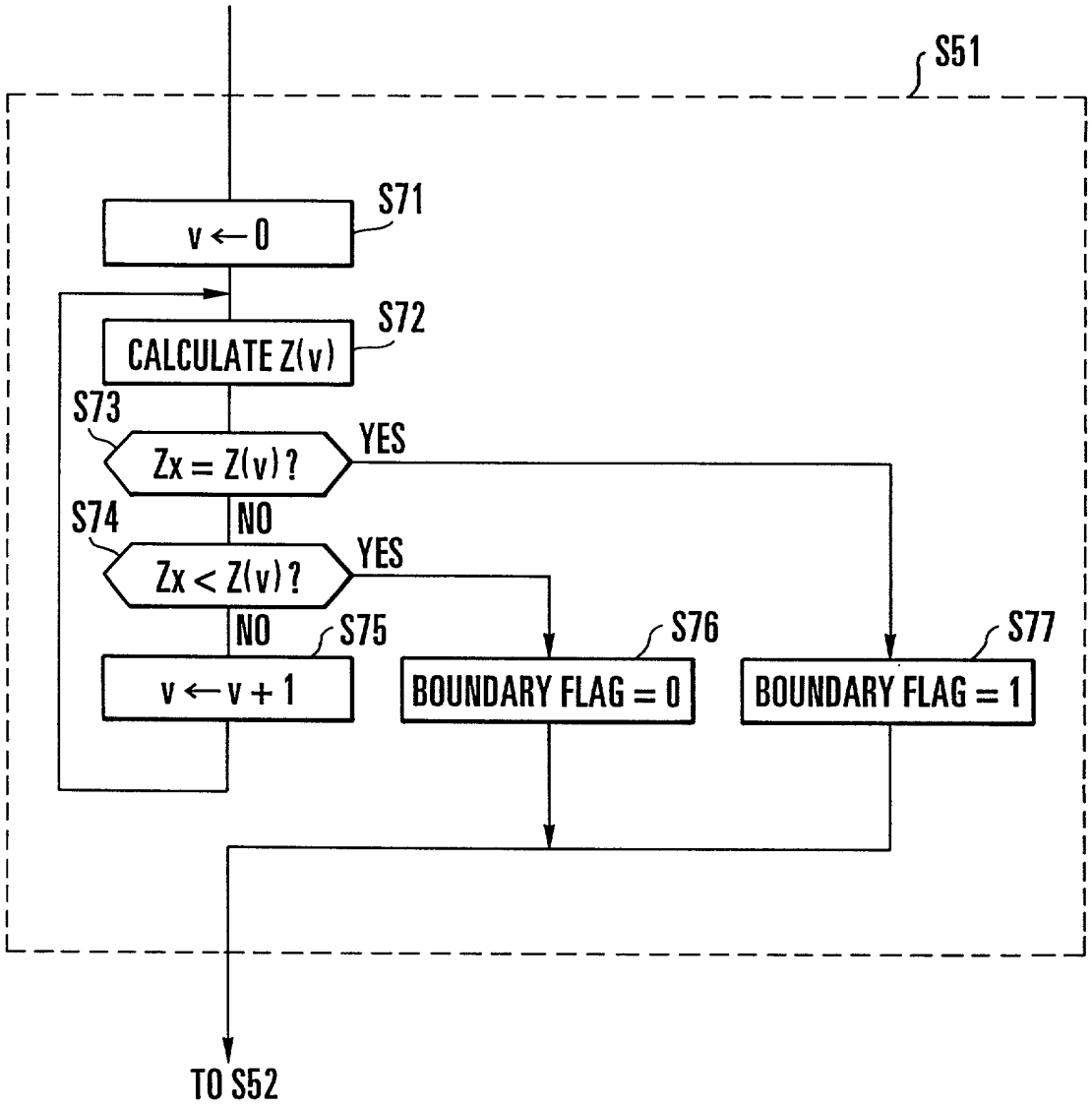
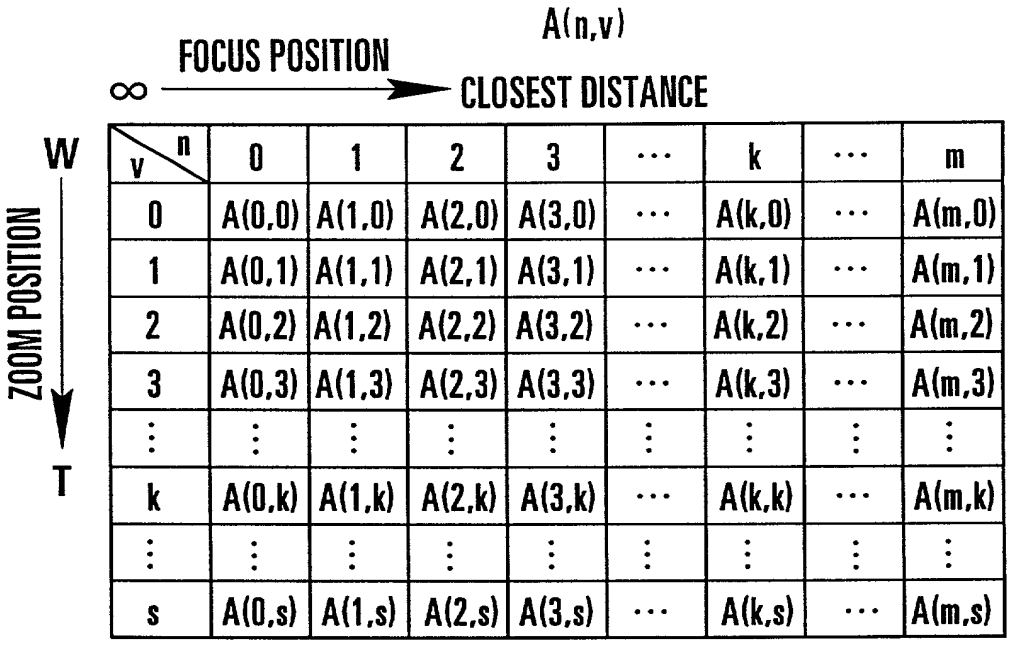
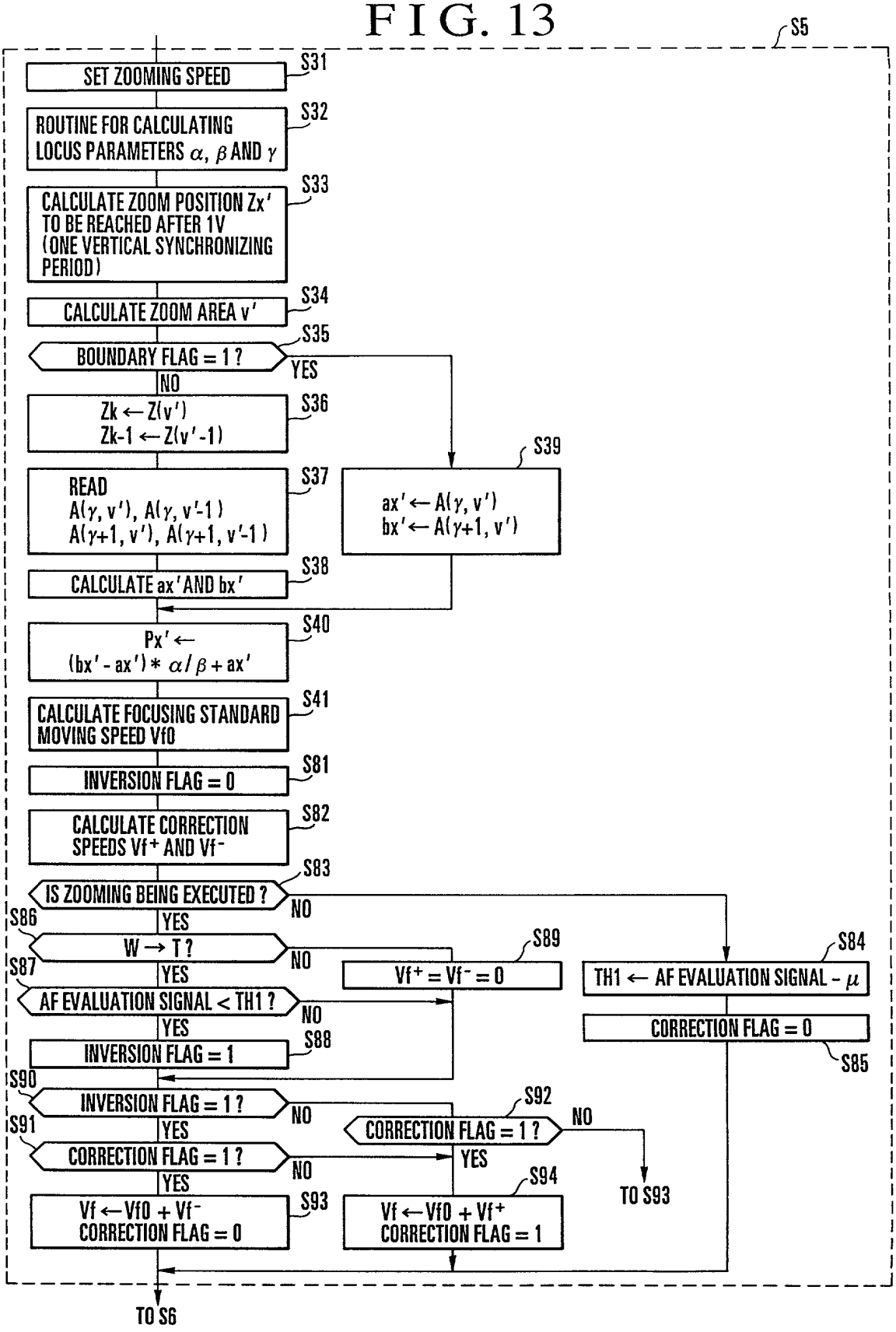

S51
S71
v ← 0
S72
CALCULATE Z(v)
S73
Zx = Z(v) ?
YES
NO
S74
Zx < Z(v) ?
YES
NO
S75
v ← v + 1
S76
BOUNDARY FLAG = 0
S77
BOUNDARY FLAG = 1
TO S52

FIG. 12



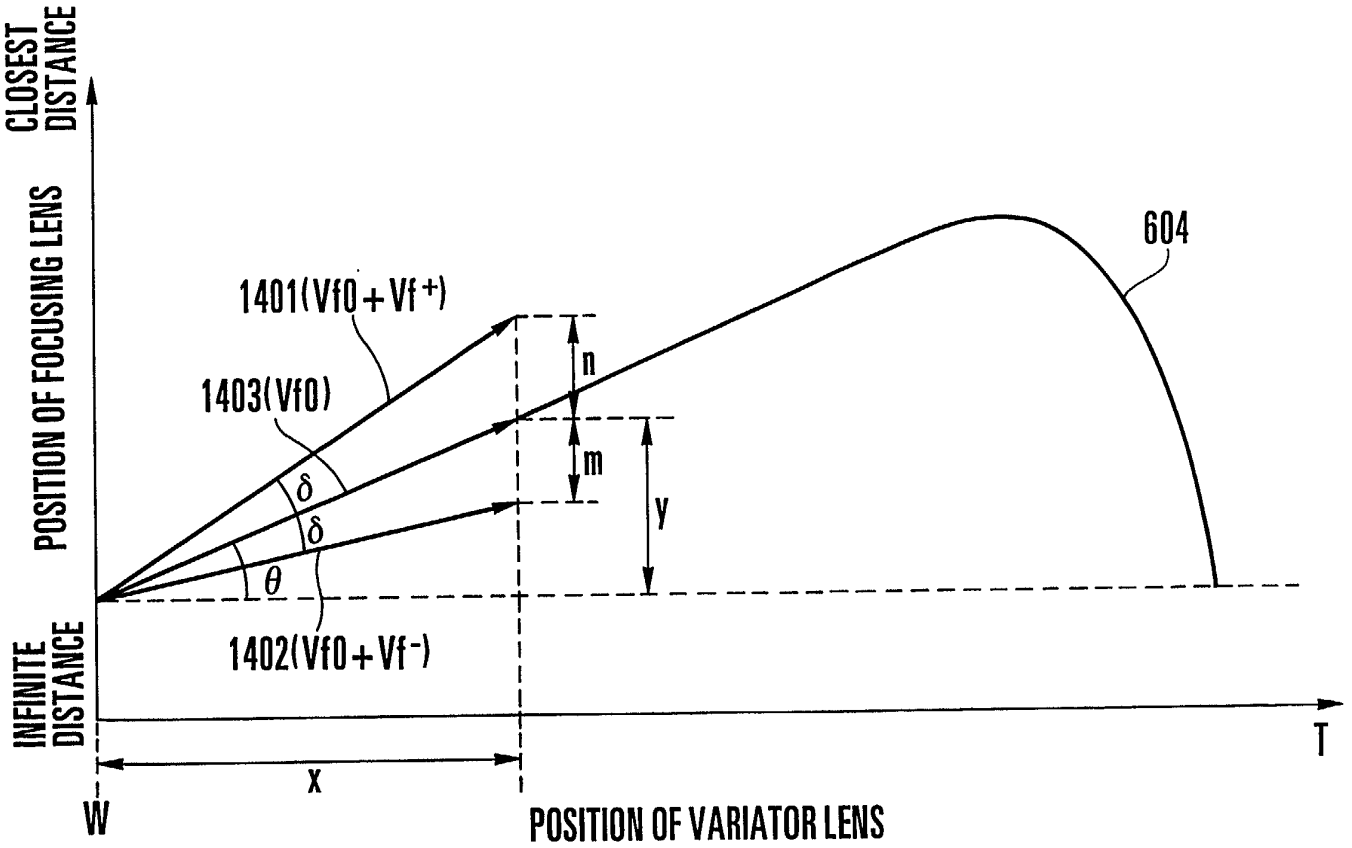
v \ n	0	1	2	3	⋯	k	⋯	m
0	A(0,0)	A(1,0)	A(2,0)	A(3,0)	⋯	A(k,0)	⋯	A(m,0)
1	A(0,1)	A(1,1)	A(2,1)	A(3,1)	⋯	A(k,1)	⋯	A(m,1)
2	A(0,2)	A(1,2)	A(2,2)	A(3,2)	⋯	A(k,2)	⋯	A(m,2)
3	A(0,3)	A(1,3)	A(2,3)	A(3,3)	⋯	A(k,3)	⋯	A(m,3)
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
k	A(0,k)	A(1,k)	A(2,k)	A(3,k)	⋯	A(k,k)	⋯	A(m,k)
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
s	A(0,s)	A(1,s)	A(2,s)	A(3,s)	⋯	A(k,s)	⋯	A(m,s)

FIG. 13


S5
SET ZOOMING SPEED
S31
ROUTINE FOR CALCULATING LOCUS PARAMETERS α, β AND γ
S32
CALCULATE ZOOM POSITION Zx' TO BE REACHED AFTER 1V (ONE VERTICAL SYNCHRONIZING PERIOD)
S33
CALCULATE ZOOM AREA v'
S34
BOUNDARY FLAG = 1 ?
S35
YES
NO
Zk ← Z(v')
Zk-1 ← Z(v'-1)
S36
READ
A(γ, v'), A(γ, v'-1)
A(γ+1, v'), A(γ+1, v'-1)
S37
CALCULATE ax' AND bx'
S38
ax' ← A(γ, v')
bx' ← A(γ+1, v')
S39
Px' ← (bx' - ax') * α/β + ax'
S40
CALCULATE FOCUSING STANDARD MOVING SPEED Vf0
S41
INVERSION FLAG = 0
S81
CALCULATE CORRECTION SPEEDS Vf+ AND Vf-
S82
IS ZOOMING BEING EXECUTED ?
S83
NO
YES
W → T ?
S86
NO
YES
AF EVALUATION SIGNAL < TH1 ?
S87
NO
YES
INVERSION FLAG = 1
S88
Vf+ = Vf- = 0
S89
TH1 ← AF EVALUATION SIGNAL - μ
S84
CORRECTION FLAG = 0
S85
INVERSION FLAG = 1 ?
S90
NO
YES
CORRECTION FLAG = 1 ?
S91
NO
YES
Vf ← Vf0 + Vf-
CORRECTION FLAG = 0
S93
CORRECTION FLAG = 1 ?
S92
NO
YES
Vf ← Vf0 + Vf+
CORRECTION FLAG = 1
S94
TO S93
TO S6

TOSHIBA 2326280

FIG. 14



TOSHIBA 2562860

FIG. 15

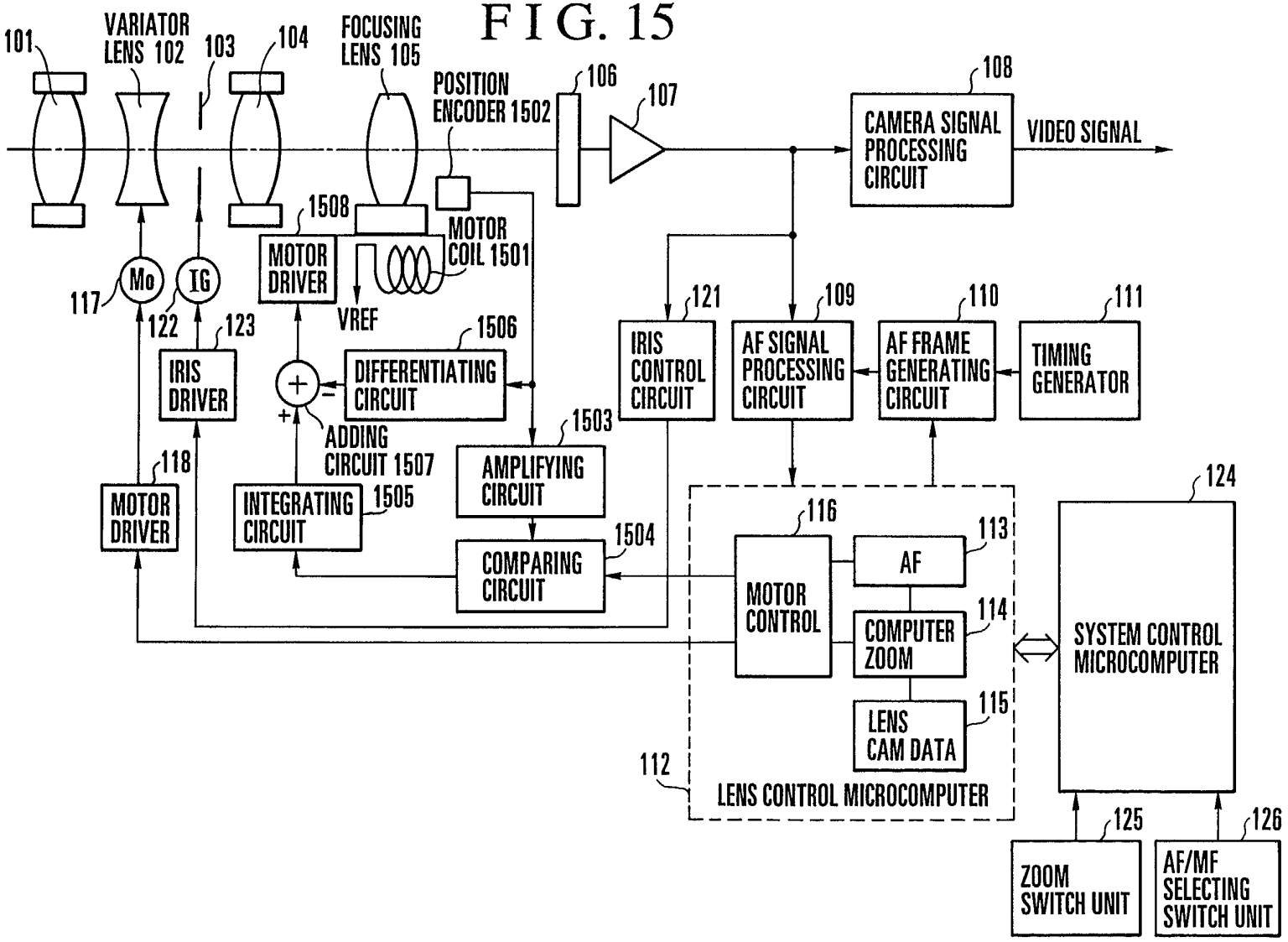


FIG. 16(A)

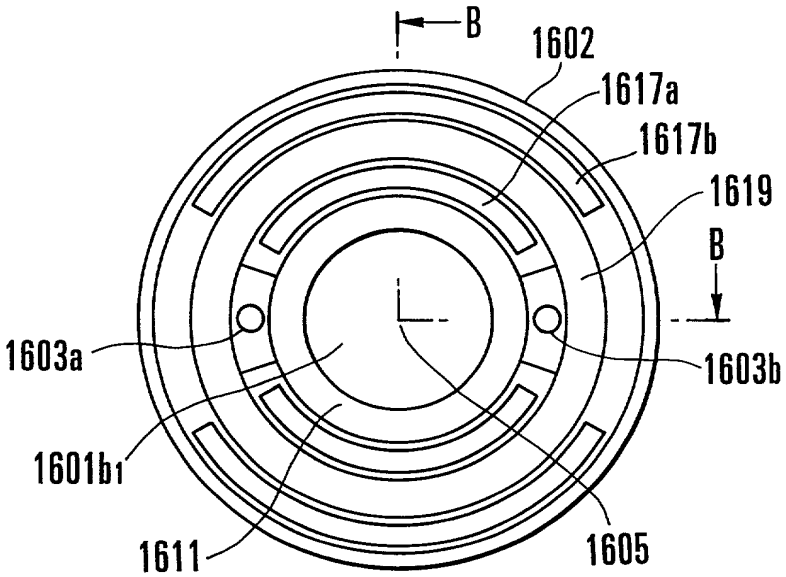


FIG. 16(B)

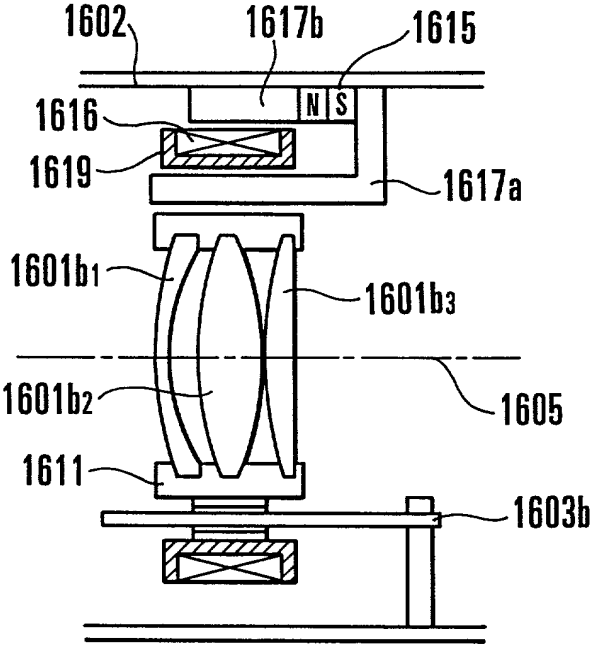
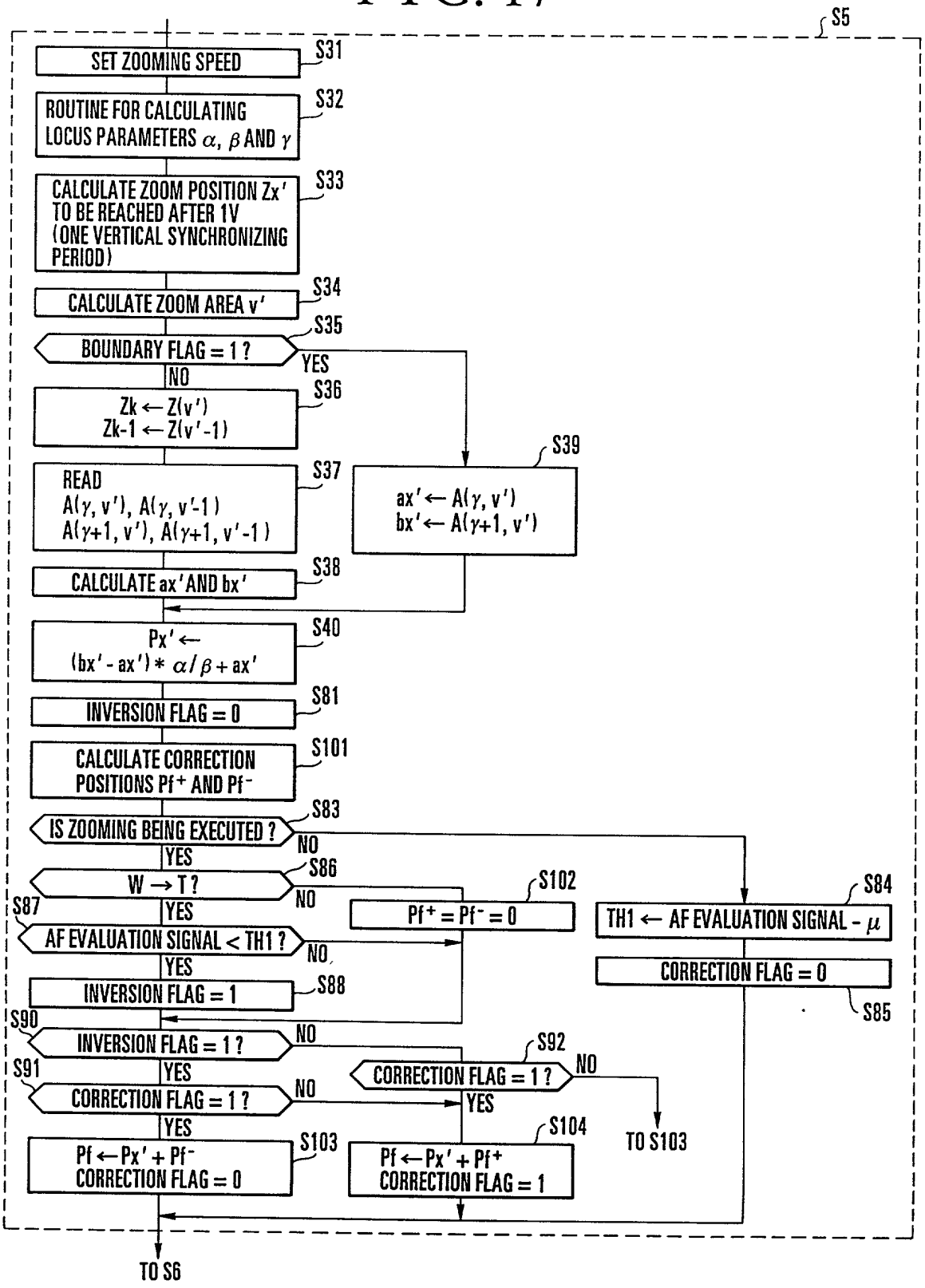


FIG. 17


S5
SET ZOOMING SPEED
S31
ROUTINE FOR CALCULATING LOCUS PARAMETERS α, β AND γ
S32
CALCULATE ZOOM POSITION Zx' TO BE REACHED AFTER 1V (ONE VERTICAL SYNCHRONIZING PERIOD)
S33
CALCULATE ZOOM AREA v'
S34
BOUNDARY FLAG = 1 ?
S35
YES
NO
Zk ← Z(v')
Zk-1 ← Z(v'-1)
S36
READ
A(γ, v'), A(γ, v'-1)
A(γ+1, v'), A(γ+1, v'-1)
S37
CALCULATE ax' AND bx'
S38
ax' ← A(γ, v')
bx' ← A(γ+1, v')
S39
Px' ← (bx' - ax') * α/β + ax'
S40
INVERSION FLAG = 0
S81
CALCULATE CORRECTION POSITIONS Pf+ AND Pf-
S101
IS ZOOMING BEING EXECUTED ?
S83
NO
YES
W → T ?
S86
NO
YES
S87
AF EVALUATION SIGNAL < TH1 ?
NO
YES
INVERSION FLAG = 1
S88
Pf+ = Pf- = 0
S102
TH1 ← AF EVALUATION SIGNAL - μ
S84
CORRECTION FLAG = 0
S85
S90
INVERSION FLAG = 1 ?
NO
YES
S91
CORRECTION FLAG = 1 ?
NO
YES
S92
CORRECTION FLAG = 1 ?
NO
YES
TO S103
Pf ← Px' + Pf-
CORRECTION FLAG = 0
S103
Pf ← Px' + Pf+
CORRECTION FLAG = 1
S104
TO S6

JP 06-268869 A 19940922

FIG. 18

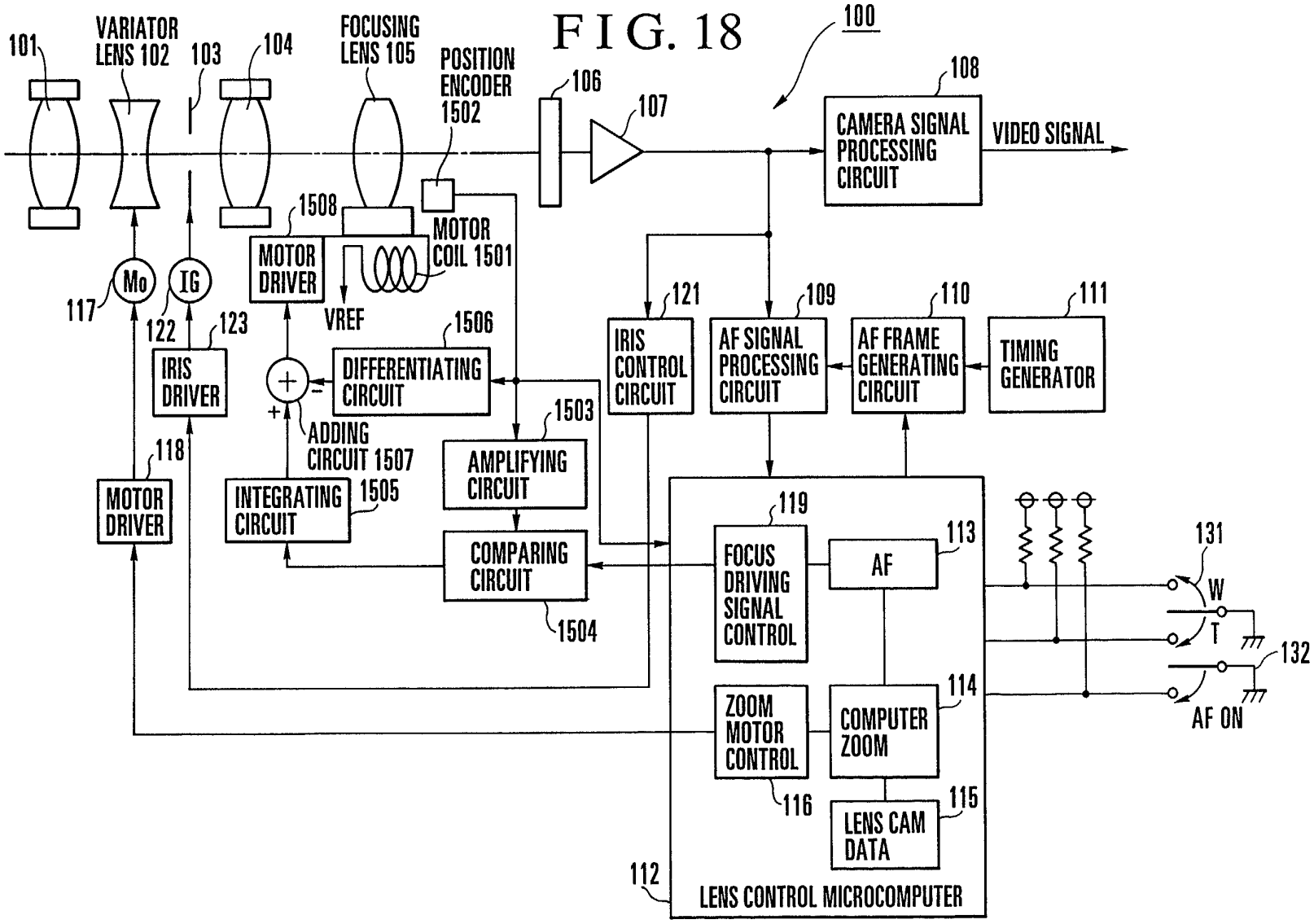


FIG. 19

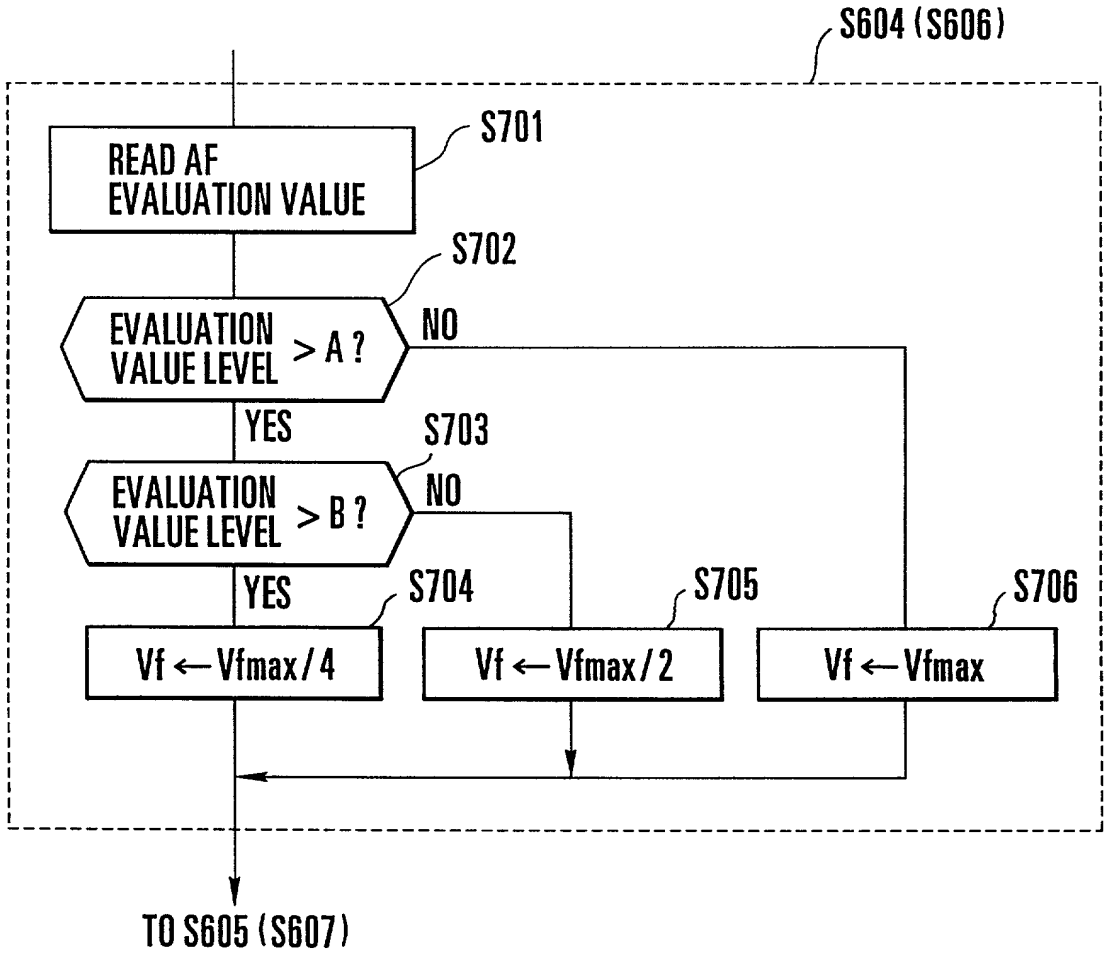

S604 (S606)
READ AF EVALUATION VALUE
S701
EVALUATION VALUE LEVEL > A ?
S702
NO
YES
EVALUATION VALUE LEVEL > B ?
S703
NO
YES
S704
S705
S706
Vf ← Vfmax / 4
Vf ← Vfmax / 2
Vf ← Vfmax
TO S605 (S607)

FIG. 20

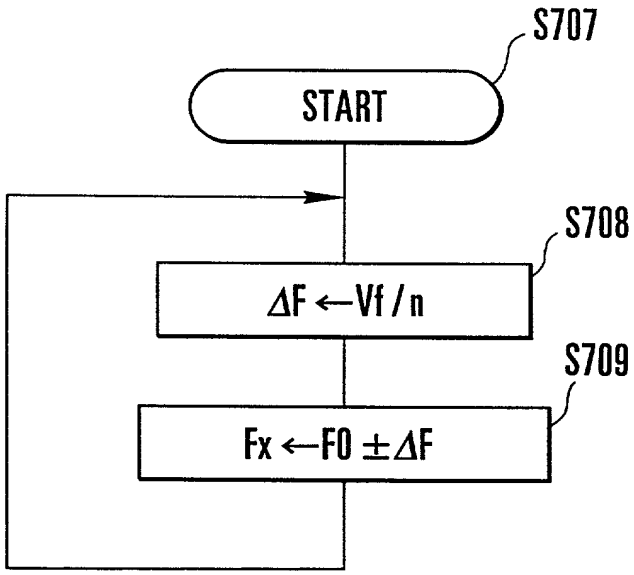


FIG. 21

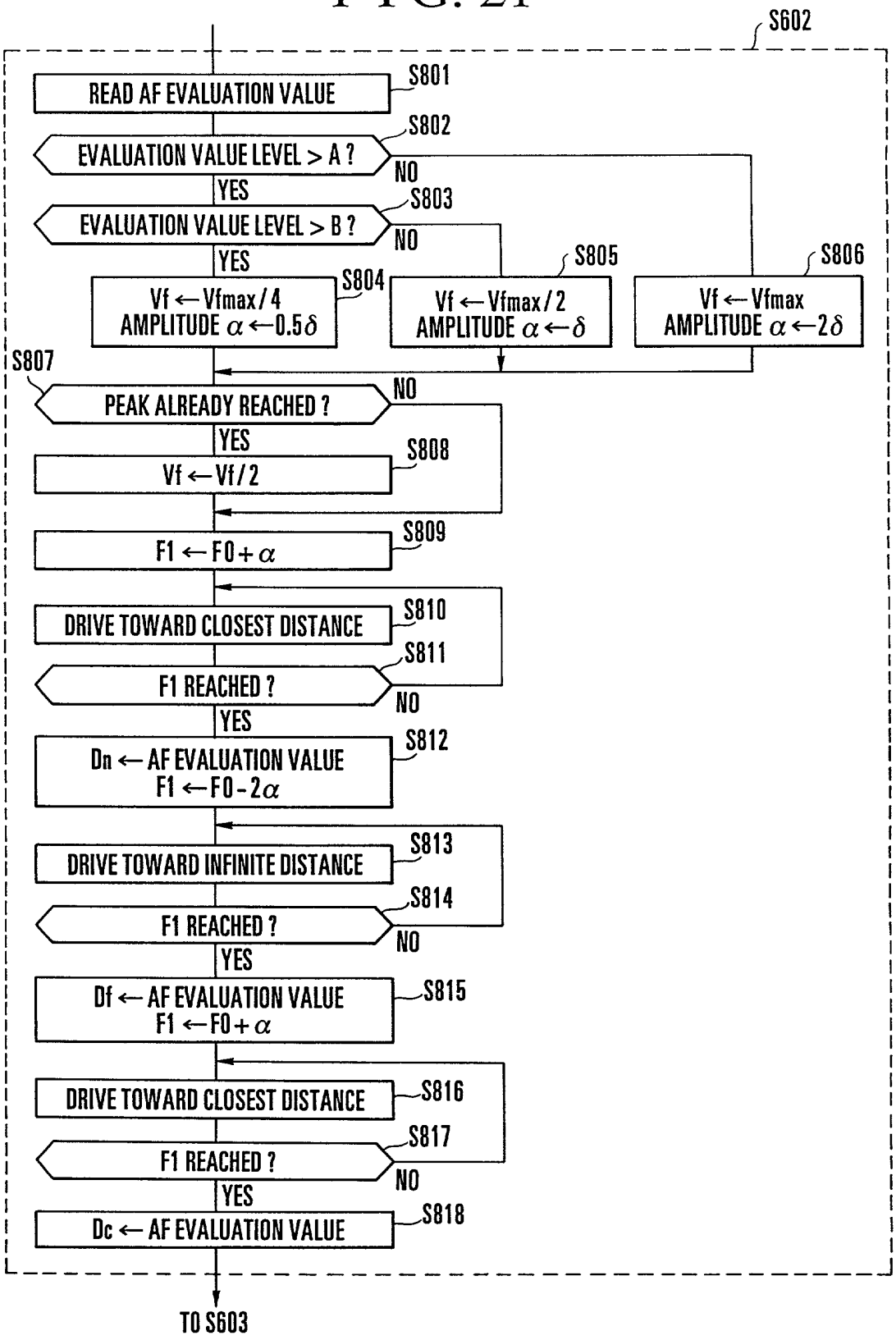

S602
READ AF EVALUATION VALUE
S801
EVALUATION VALUE LEVEL > A ?
S802
NO
YES
EVALUATION VALUE LEVEL > B ?
S803
NO
YES
Vf ← Vfmax / 4
AMPLITUDE α ← 0.5δ
S804
Vf ← Vfmax / 2
AMPLITUDE α ← δ
S805
Vf ← Vfmax
AMPLITUDE α ← 2δ
S806
S807
PEAK ALREADY REACHED ?
NO
YES
Vf ← Vf / 2
S808
F1 ← F0 + α
S809
DRIVE TOWARD CLOSEST DISTANCE
S810
F1 REACHED ?
S811
NO
YES
Dn ← AF EVALUATION VALUE
F1 ← F0 - 2α
S812
DRIVE TOWARD INFINITE DISTANCE
S813
F1 REACHED ?
S814
NO
YES
Df ← AF EVALUATION VALUE
F1 ← F0 + α
S815
DRIVE TOWARD CLOSEST DISTANCE
S816
F1 REACHED ?
S817
NO
YES
Dc ← AF EVALUATION VALUE
S818
TO S603

FIG. 22

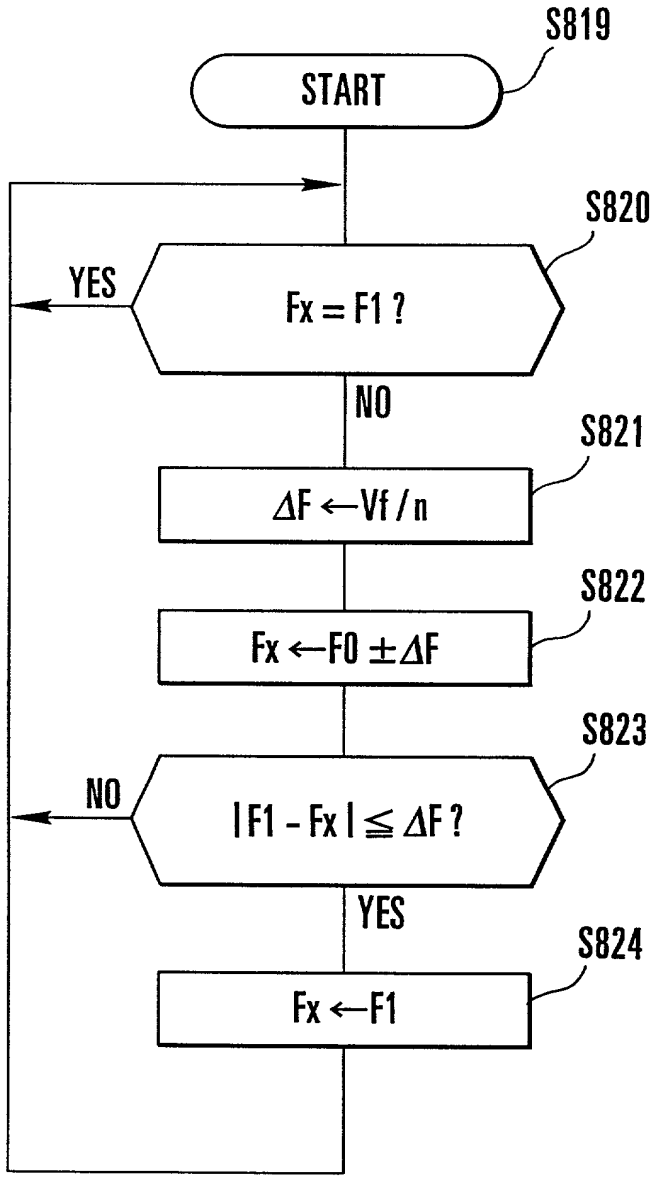

S819
START
S820
YES
Fx = F1 ?
NO
S821
ΔF ← Vf / n
S822
Fx ← F0 ± ΔF
S823
NO
| F1 - Fx | ≦ ΔF ?
YES
S824
Fx ← F1

FIG. 23

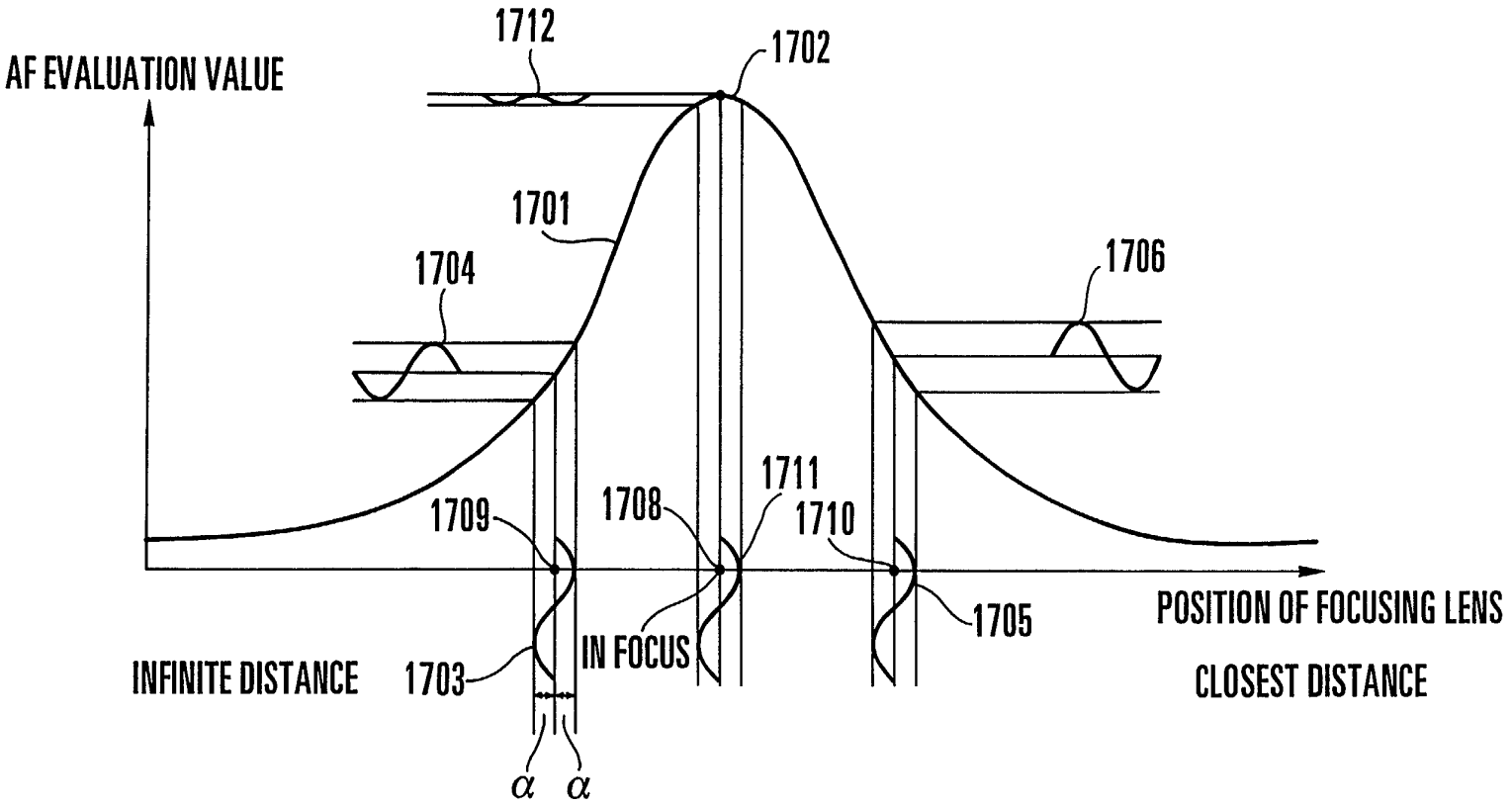

AF EVALUATION VALUE
1712
1702
1701
1704
1706
1709
1708
1711
1710
1705
POSITION OF FOCUSING LENS
INFINITE DISTANCE
1703
IN FOCUS
CLOSEST DISTANCE
α
α

FIG. 24

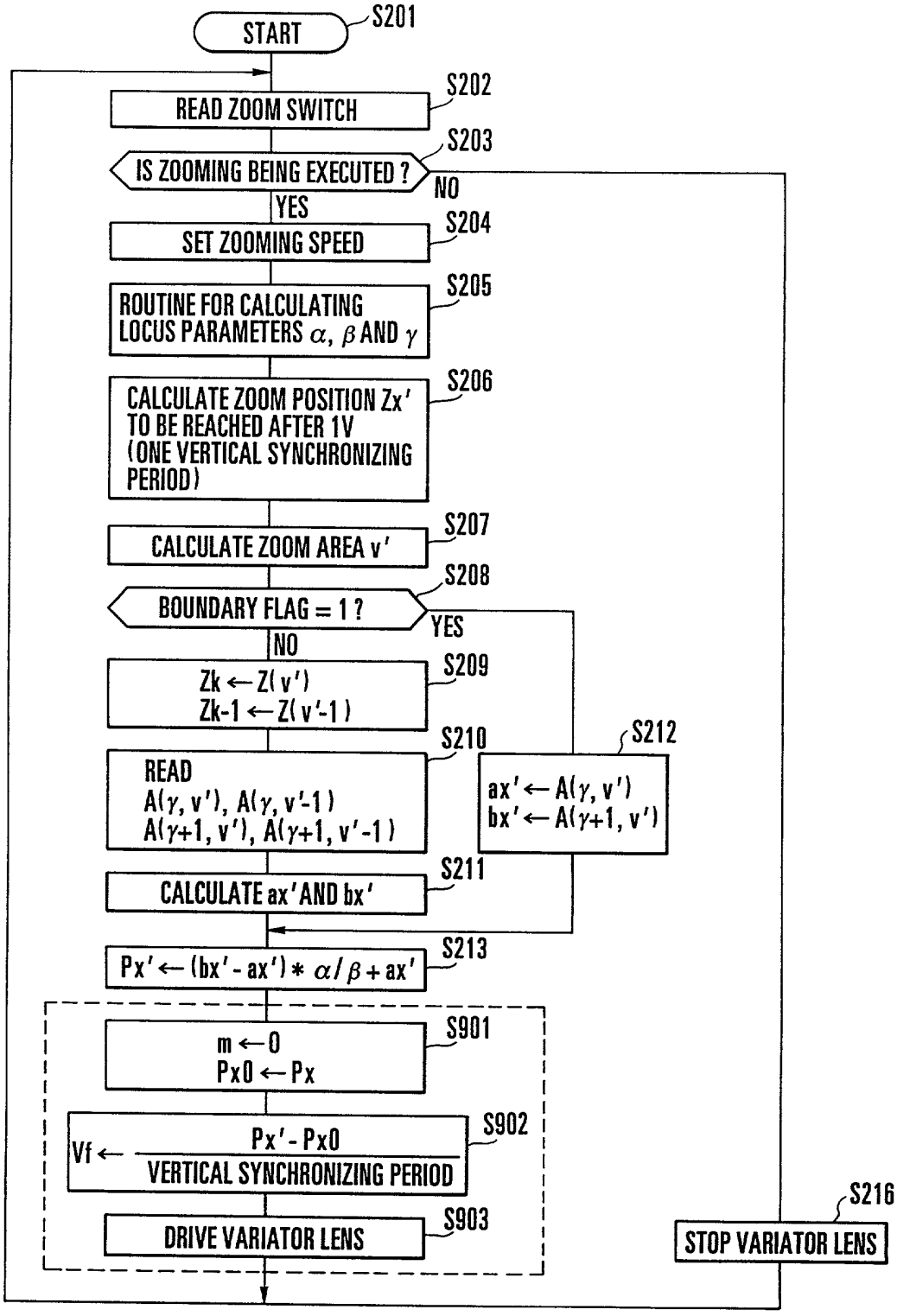

START
S201
READ ZOOM SWITCH
S202
IS ZOOMING BEING EXECUTED ?
S203
NO
YES
SET ZOOMING SPEED
S204
ROUTINE FOR CALCULATING LOCUS PARAMETERS α, β AND γ
S205
CALCULATE ZOOM POSITION Zx' TO BE REACHED AFTER 1V (ONE VERTICAL SYNCHRONIZING PERIOD)
S206
CALCULATE ZOOM AREA v'
S207
BOUNDARY FLAG = 1 ?
S208
YES
NO
Zk ← Z(v')
Zk-1 ← Z(v'-1)
S209
READ
A(γ, v'), A(γ, v'-1)
A(γ+1, v'), A(γ+1, v'-1)
S210
ax' ← A(γ, v')
bx' ← A(γ+1, v')
S212
CALCULATE ax' AND bx'
S211
Px' ← (bx' - ax') * α/β + ax'
S213
m ← 0
Px0 ← Px
S901
Vf ← (Px' - Px0) / VERTICAL SYNCHRONIZING PERIOD
S902
DRIVE VARIATOR LENS
S903
STOP VARIATOR LENS
S216

FIG. 25

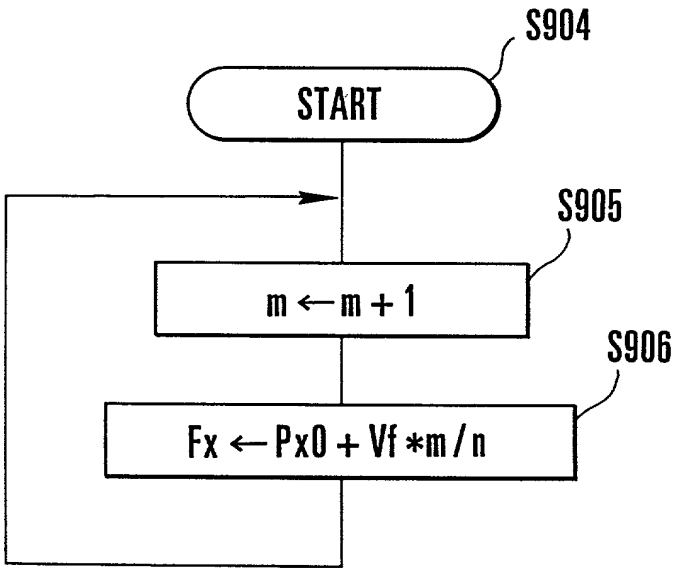


FIG. 26

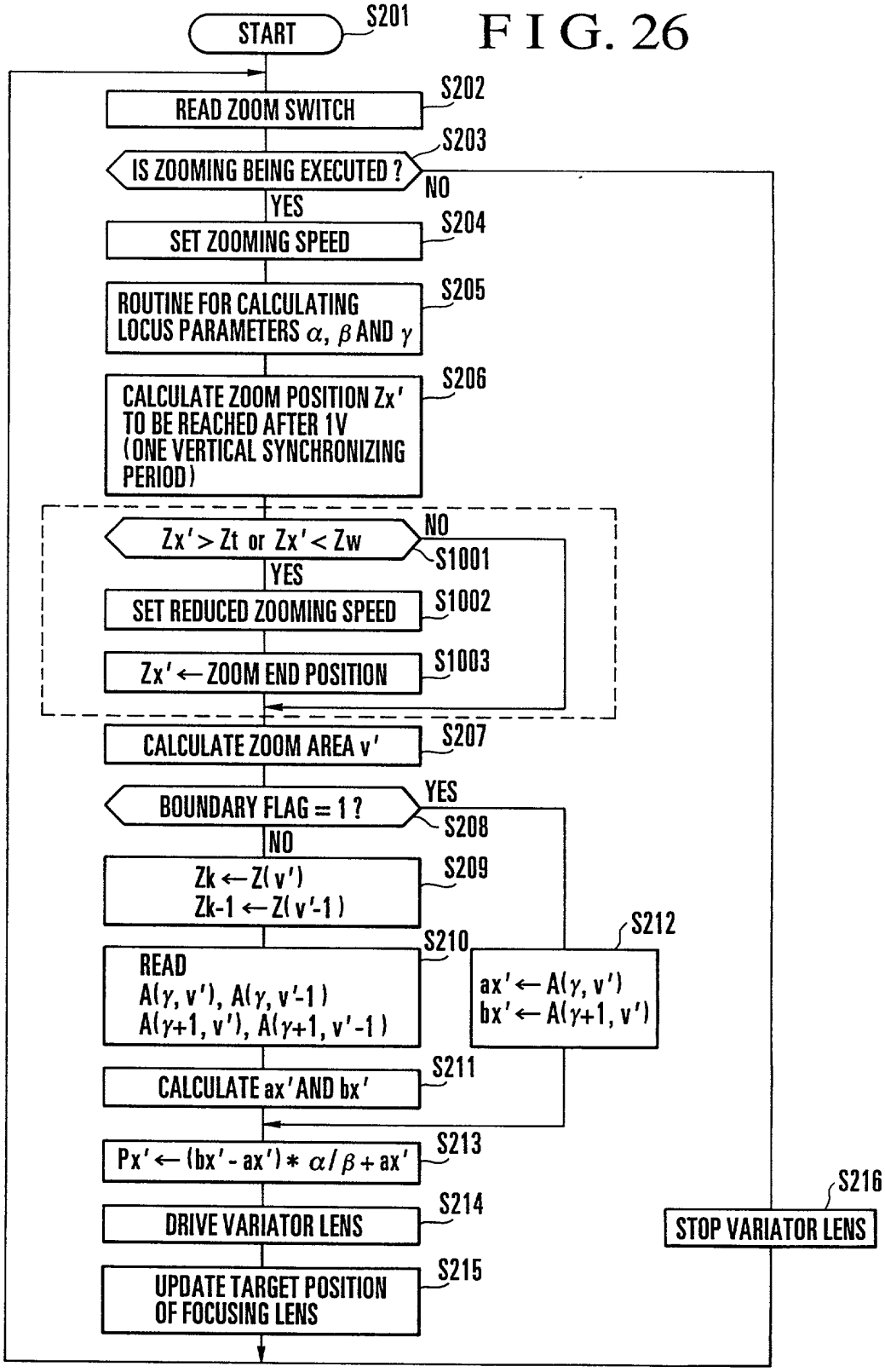
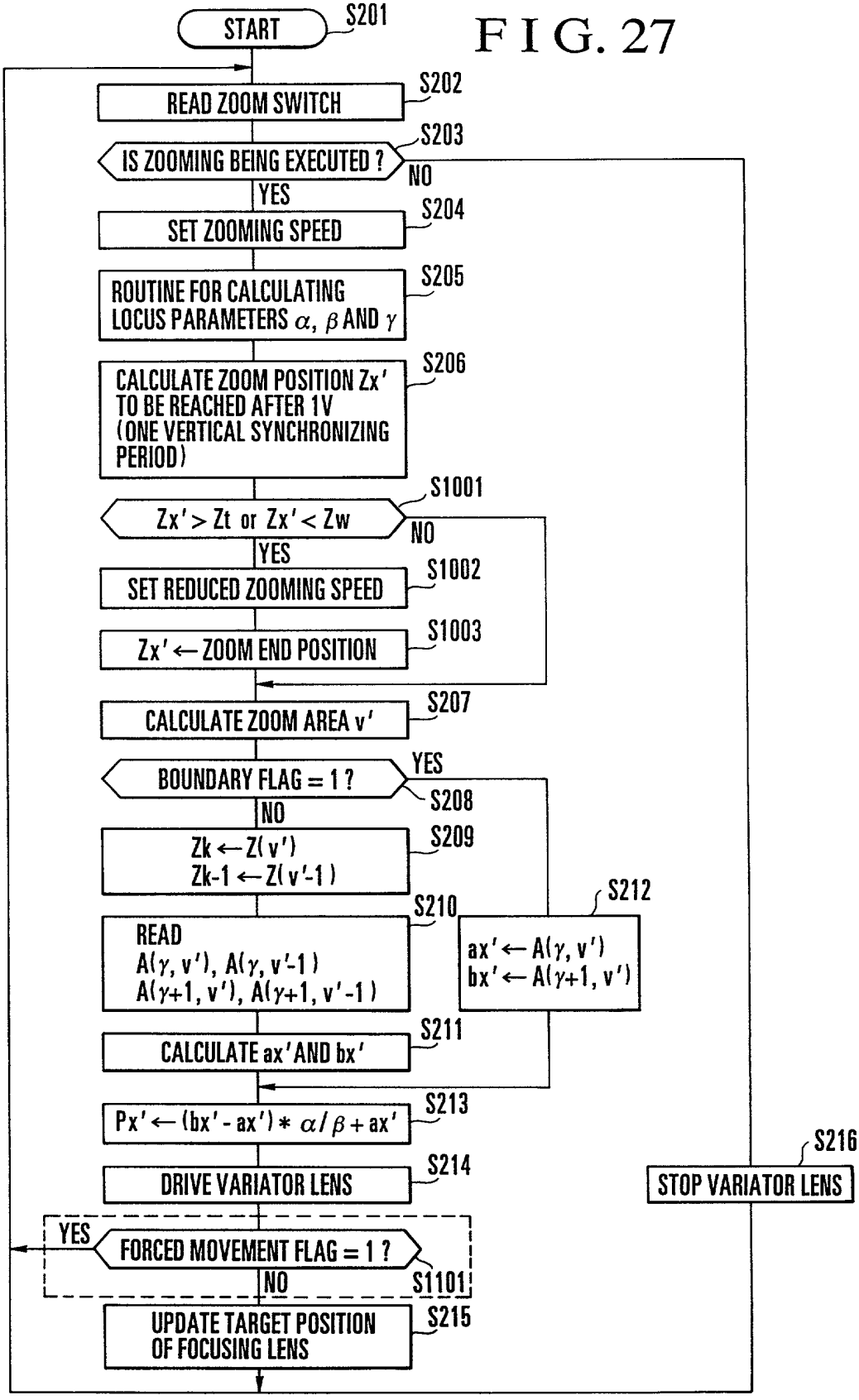

START
S201
READ ZOOM SWITCH
S202
IS ZOOMING BEING EXECUTED ?
S203
NO
YES
SET ZOOMING SPEED
S204
ROUTINE FOR CALCULATING LOCUS PARAMETERS α, β AND γ
S205
CALCULATE ZOOM POSITION Zx' TO BE REACHED AFTER 1V (ONE VERTICAL SYNCHRONIZING PERIOD)
S206
Zx' > Zt or Zx' < Zw
NO
S1001
YES
SET REDUCED ZOOMING SPEED
S1002
Zx' ← ZOOM END POSITION
S1003
CALCULATE ZOOM AREA v'
S207
BOUNDARY FLAG = 1 ?
YES
S208
NO
Zk ← Z(v')
Zk-1 ← Z(v'-1)
S209
READ
A(γ, v'), A(γ, v'-1)
A(γ+1, v'), A(γ+1, v'-1)
S210
ax' ← A(γ, v')
bx' ← A(γ+1, v')
S212
CALCULATE ax' AND bx'
S211
Px' ← (bx' - ax') * α/β + ax'
S213
DRIVE VARIATOR LENS
S214
UPDATE TARGET POSITION OF FOCUSING LENS
S215
STOP VARIATOR LENS
S216

FIG. 27


START
S201
READ ZOOM SWITCH
S202
IS ZOOMING BEING EXECUTED ?
S203
NO
YES
SET ZOOMING SPEED
S204
ROUTINE FOR CALCULATING LOCUS PARAMETERS α, β AND γ
S205
CALCULATE ZOOM POSITION Zx' TO BE REACHED AFTER 1V (ONE VERTICAL SYNCHRONIZING PERIOD)
S206
Zx' > Zt or Zx' < Zw
S1001
NO
YES
SET REDUCED ZOOMING SPEED
S1002
Zx' ← ZOOM END POSITION
S1003
CALCULATE ZOOM AREA v'
S207
BOUNDARY FLAG = 1 ?
YES
S208
NO
Zk ← Z(v')
Zk-1 ← Z(v'-1)
S209
READ
A(γ, v'), A(γ, v'-1)
A(γ+1, v'), A(γ+1, v'-1)
S210
ax' ← A(γ, v')
bx' ← A(γ+1, v')
S212
CALCULATE ax' AND bx'
S211
Px' ← (bx' - ax') * α/β + ax'
S213
DRIVE VARIATOR LENS
S214
YES
FORCED MOVEMENT FLAG = 1 ?
NO
S1101
UPDATE TARGET POSITION OF FOCUSING LENS
S215
STOP VARIATOR LENS
S216

TOSHIBA EXHIBIT

FIG. 28

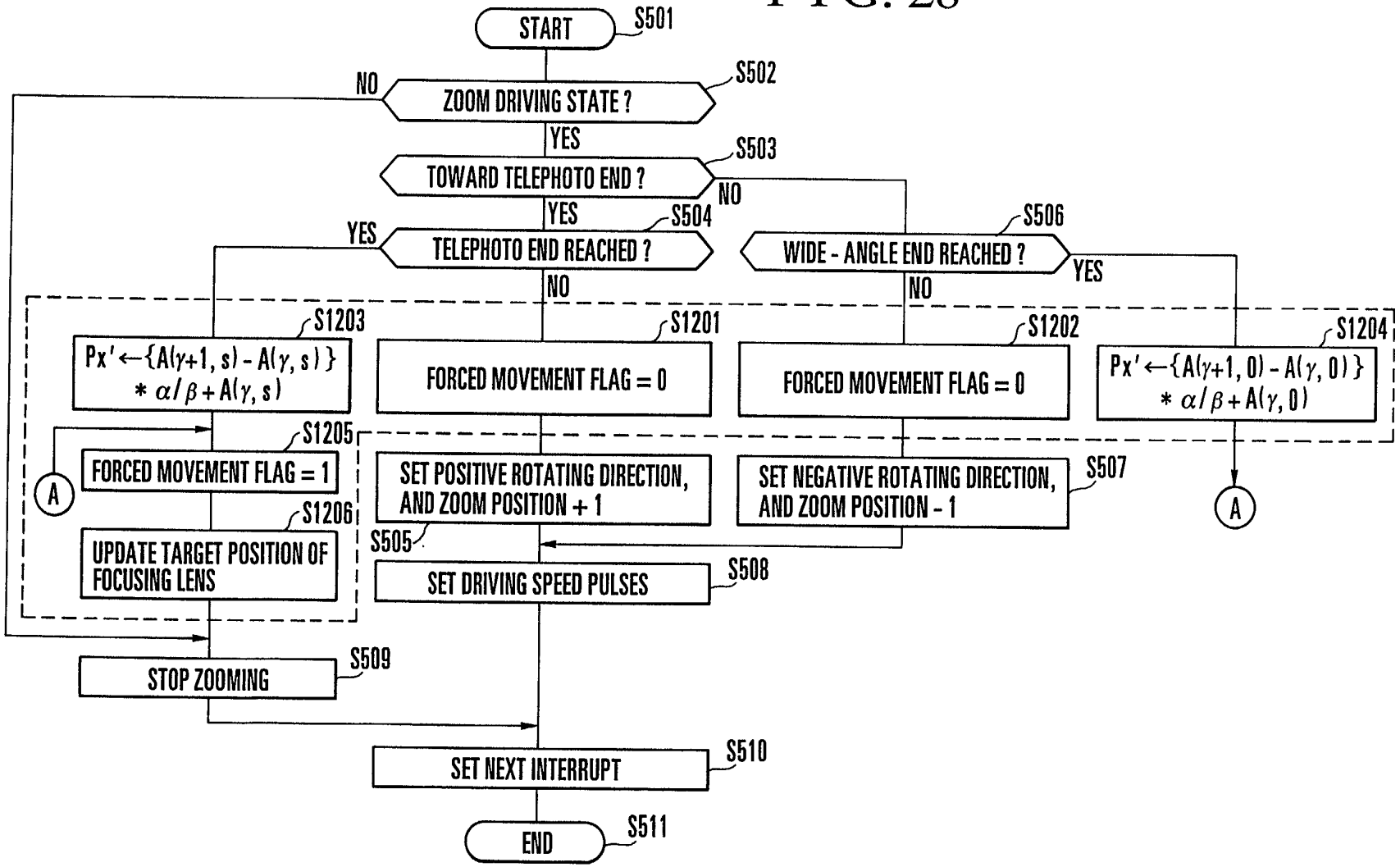


FIG. 29

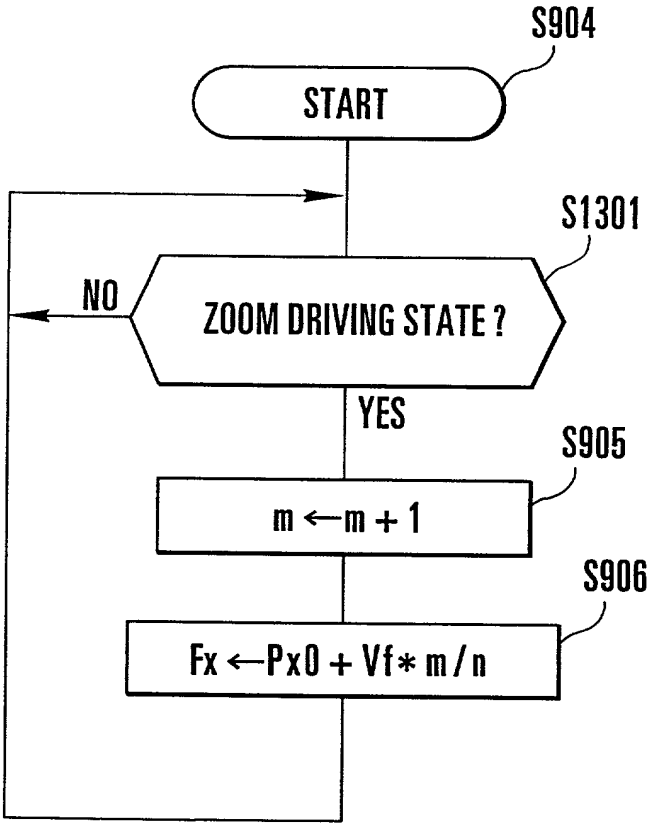

S904
START
S1301
NO
ZOOM DRIVING STATE ?
YES
S905
m ← m + 1
S906
Fx ← Px0 + Vf * m / n

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FIG. 30

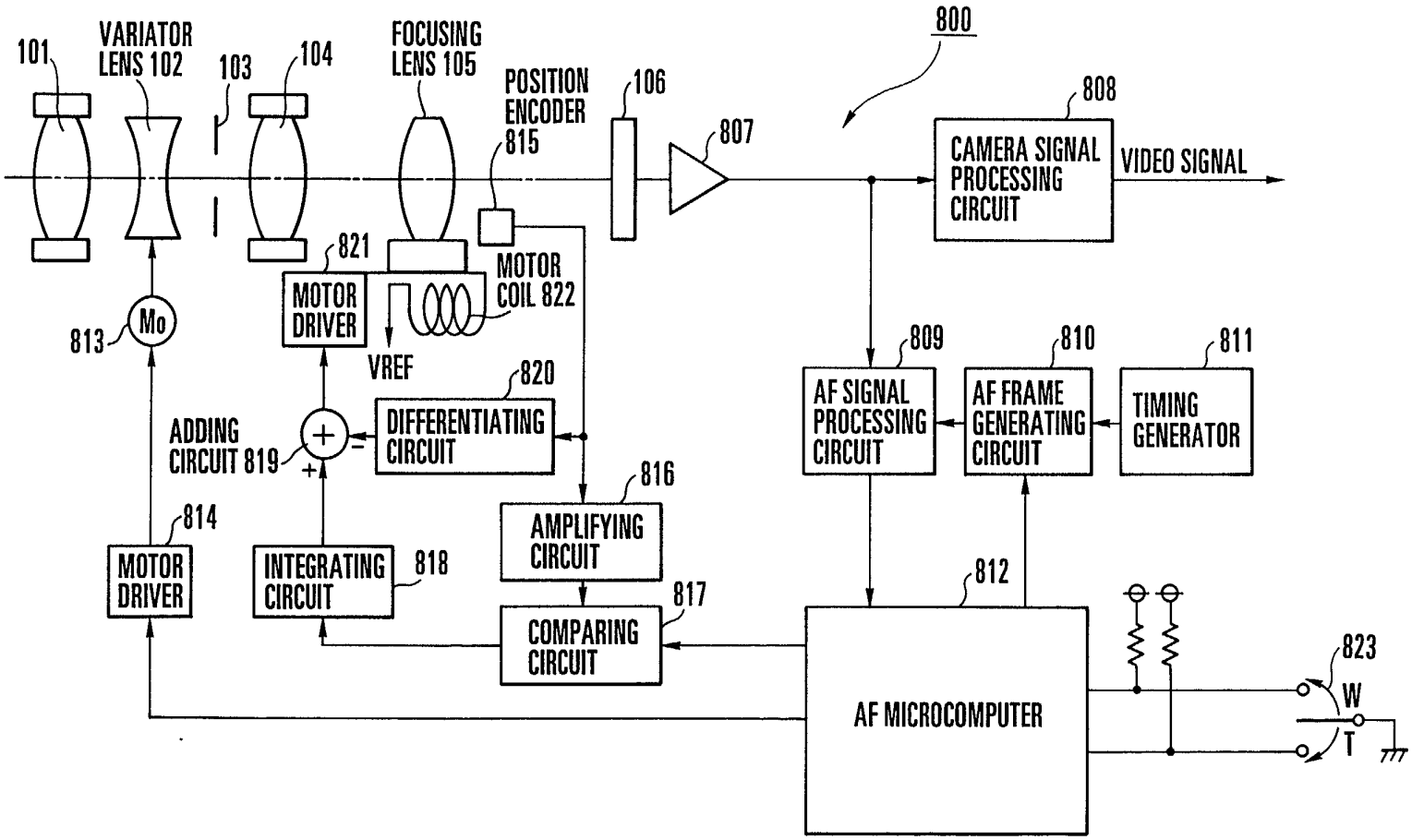


FIG. 31

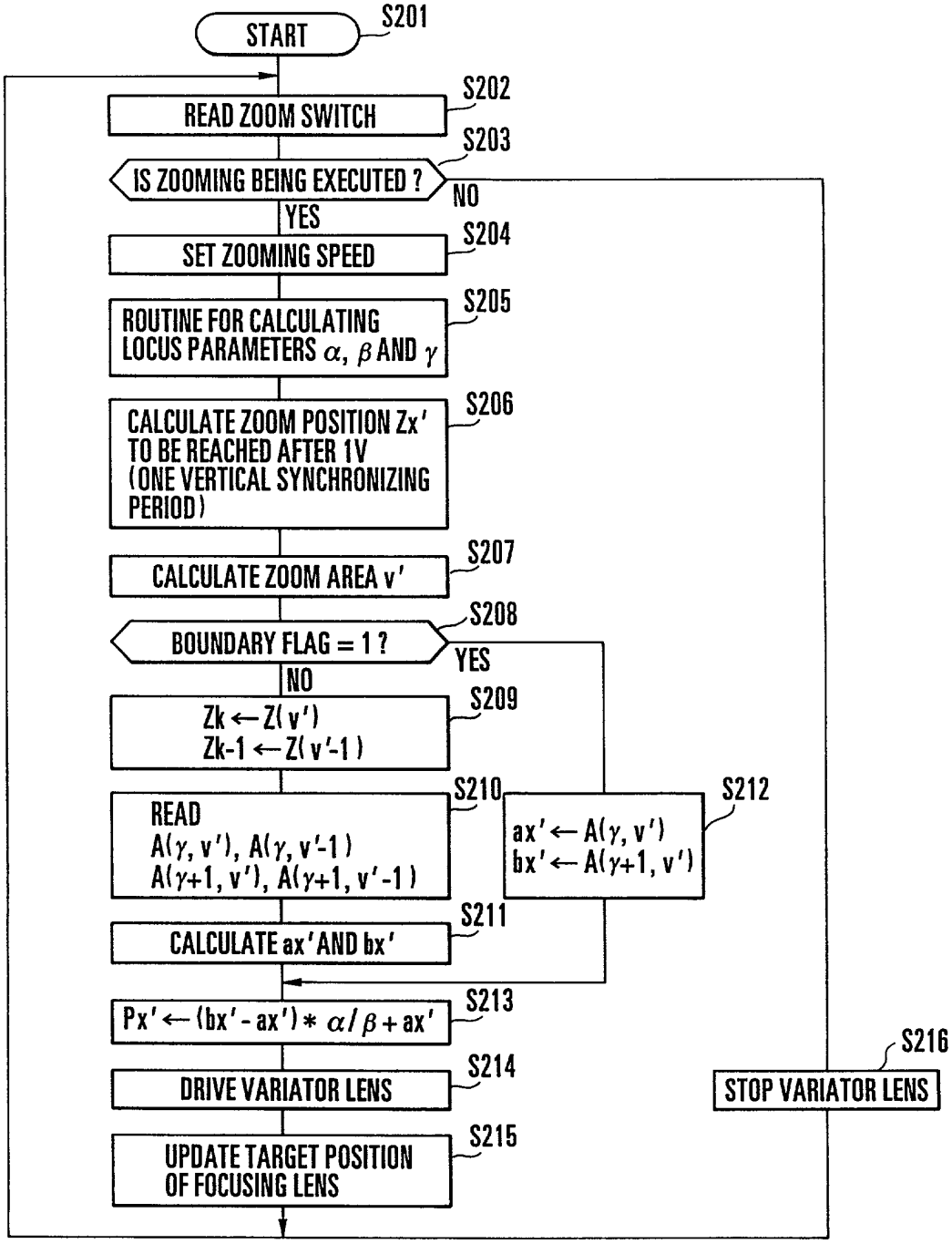

START
S201
READ ZOOM SWITCH
S202
IS ZOOMING BEING EXECUTED ?
S203
NO
YES
SET ZOOMING SPEED
S204
ROUTINE FOR CALCULATING LOCUS PARAMETERS α, β AND γ
S205
CALCULATE ZOOM POSITION Zx' TO BE REACHED AFTER 1V (ONE VERTICAL SYNCHRONIZING PERIOD)
S206
CALCULATE ZOOM AREA v'
S207
BOUNDARY FLAG = 1 ?
S208
YES
NO
Zk ← Z(v')
Zk-1 ← Z(v'-1)
S209
READ
A(γ, v'), A(γ, v'-1)
A(γ+1, v'), A(γ+1, v'-1)
S210
ax' ← A(γ, v')
bx' ← A(γ+1, v')
S212
CALCULATE ax' AND bx'
S211
Px' ← (bx' - ax') * α/β + ax'
S213
DRIVE VARIATOR LENS
S214
UPDATE TARGET POSITION OF FOCUSING LENS
S215
STOP VARIATOR LENS
S216

FIG. 32

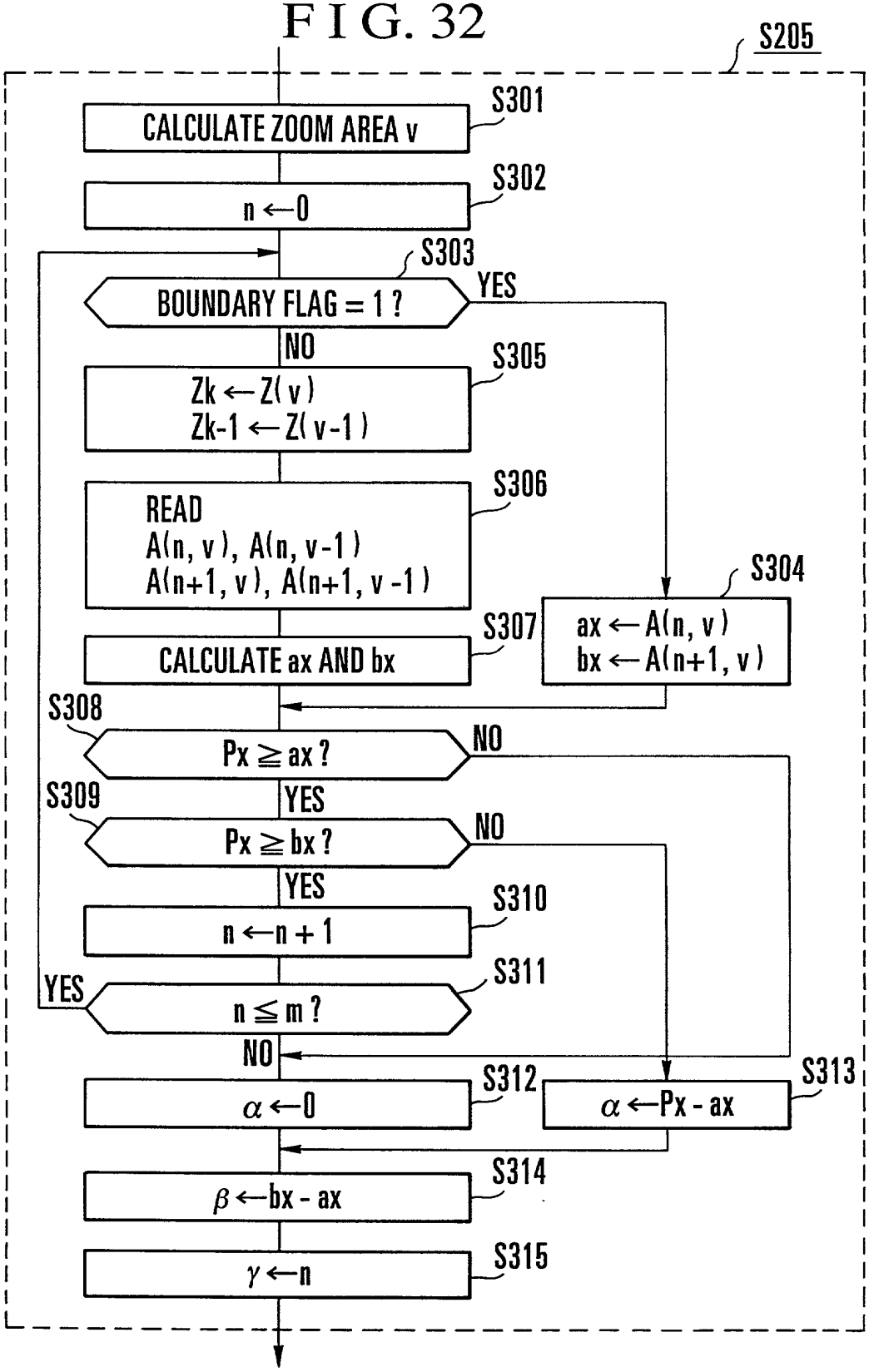

S205
S301
CALCULATE ZOOM AREA v
S302
n ← 0
S303
BOUNDARY FLAG = 1 ?
YES
NO
S305
Zk ← Z(v)
Zk-1 ← Z(v-1)
S306
READ
A(n, v), A(n, v-1)
A(n+1, v), A(n+1, v -1)
S304
ax ← A(n, v)
bx ← A(n+1, v)
S307
CALCULATE ax AND bx
S308
Px ≧ ax ?
NO
S309
YES
Px ≧ bx ?
NO
YES
S310
n ← n + 1
S311
YES
n ≦ m ?
NO
S312
α ← 0
S313
α ← Px - ax
S314
β ← bx - ax
S315
γ ← n

FIG. 33

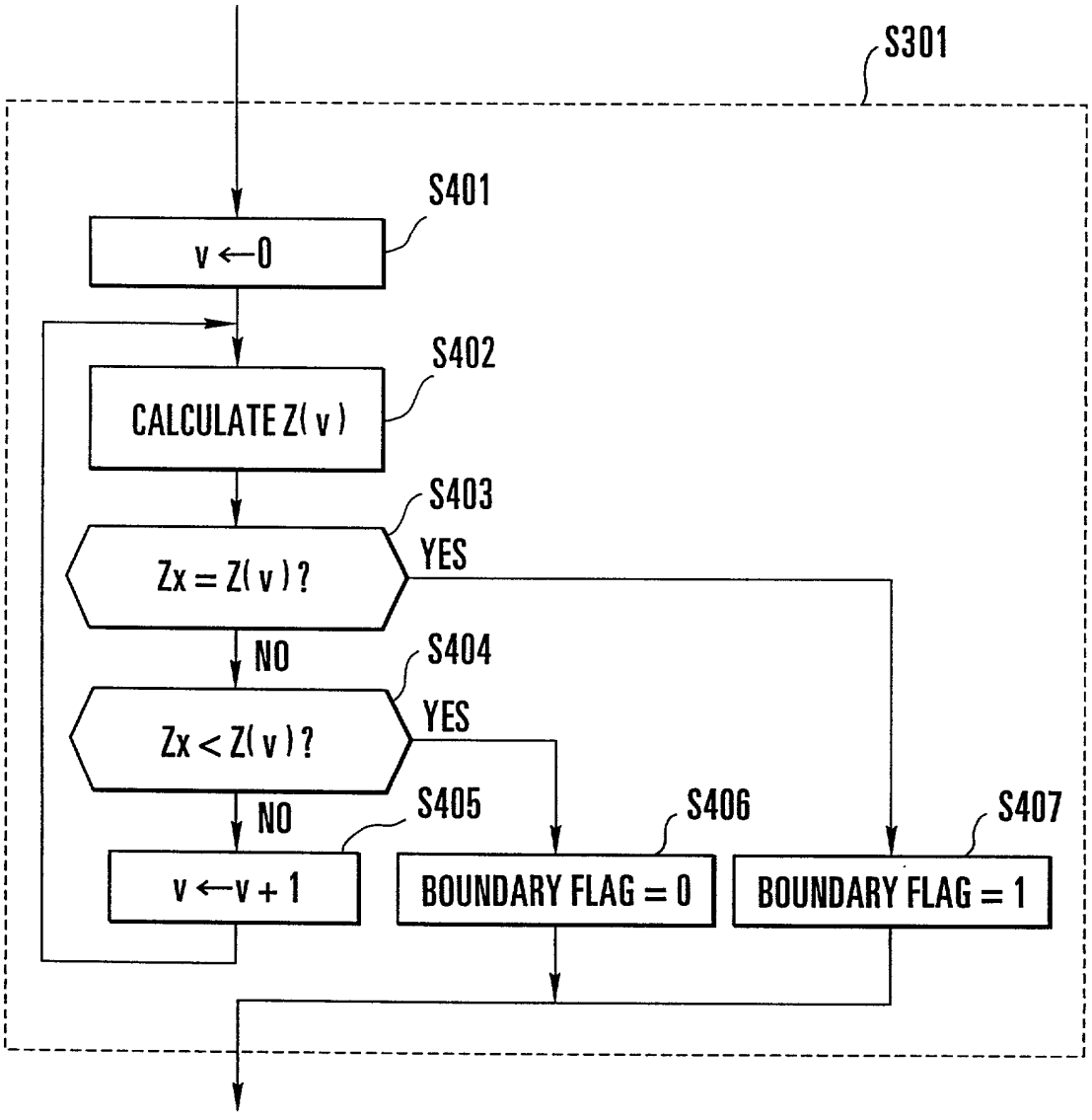

S301
S401
v ← 0
S402
CALCULATE Z(v)
S403
Zx = Z(v) ?
YES
NO
S404
Zx < Z(v) ?
YES
NO
S405
S406
S407
v ← v + 1
BOUNDARY FLAG = 0
BOUNDARY FLAG = 1

FIG. 34

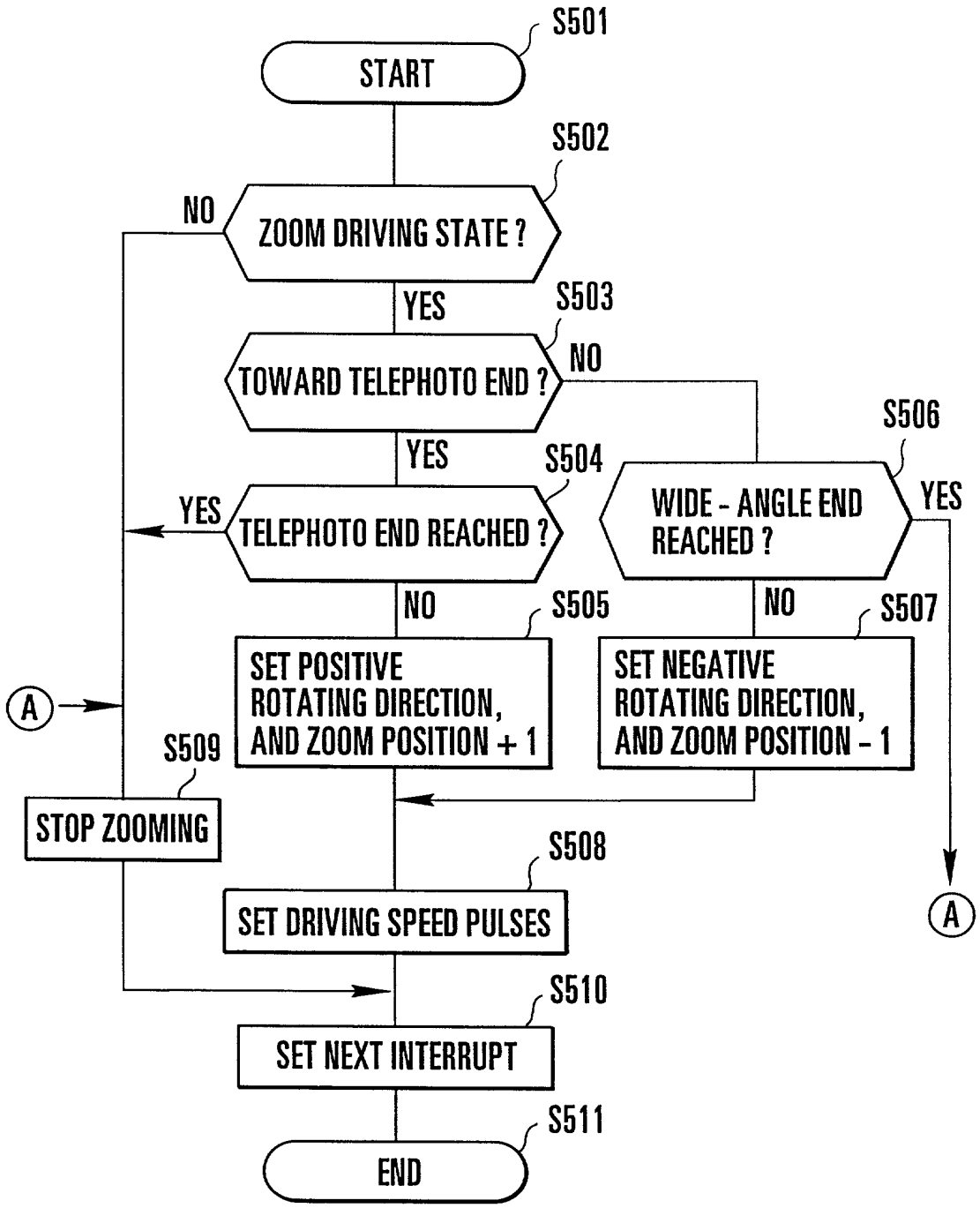

S501
START
S502
NO
ZOOM DRIVING STATE ?
YES
S503
TOWARD TELEPHOTO END ?
NO
YES
S504
YES
TELEPHOTO END REACHED ?
S506
WIDE - ANGLE END REACHED ?
YES
NO
S505
NO
S507
SET POSITIVE ROTATING DIRECTION, AND ZOOM POSITION + 1
SET NEGATIVE ROTATING DIRECTION, AND ZOOM POSITION - 1
A
S509
STOP ZOOMING
S508
SET DRIVING SPEED PULSES
A
S510
SET NEXT INTERRUPT
S511
END

FIG. 35

TB

A(n,v)

∞ FOCUS POSITION → CLOSEST DISTANCE

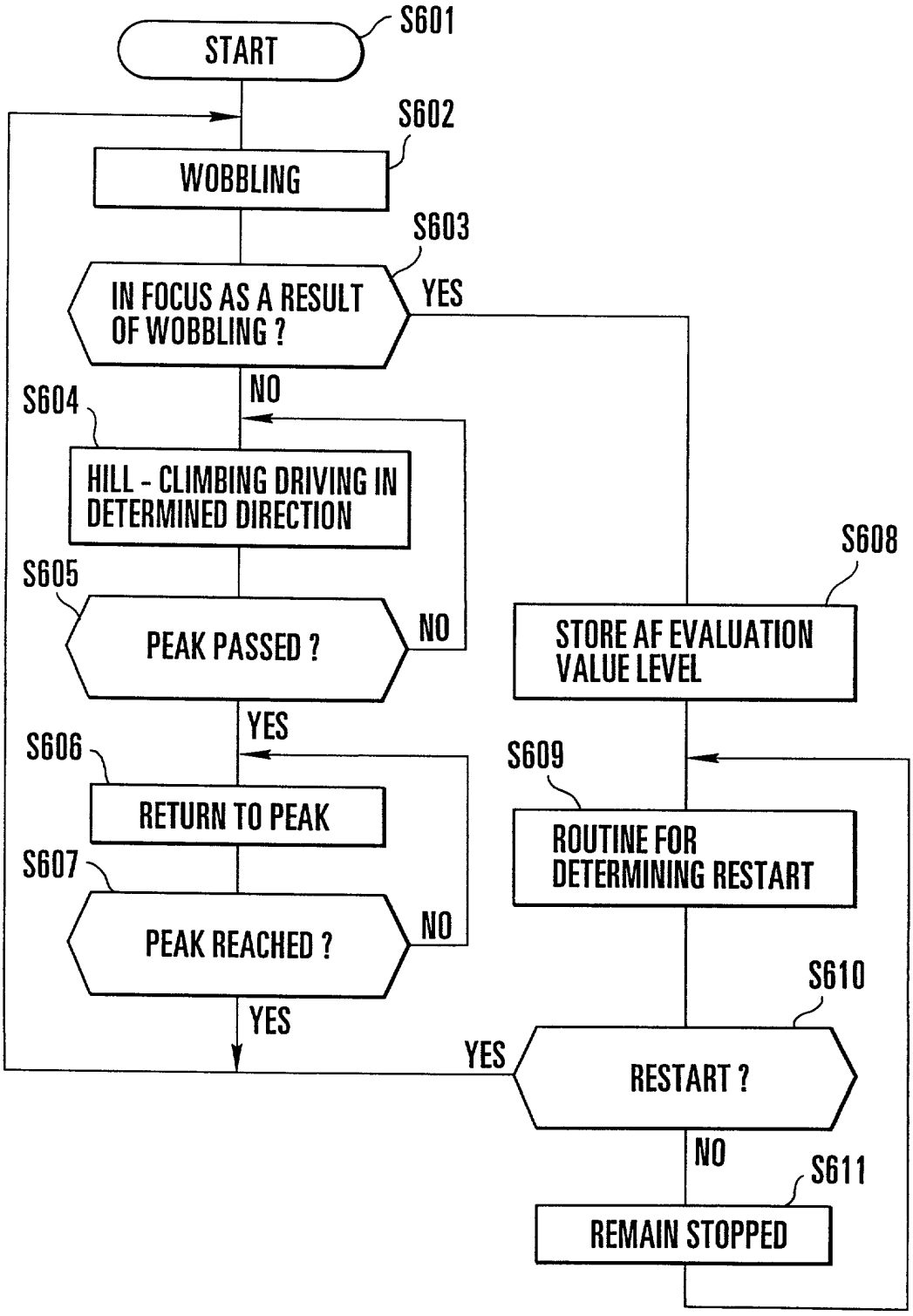
W

ZOOM POSITION

T

v \ n	0	1	2	3	⋯	k	⋯	m
0	A(0,0)	A(1,0)	A(2,0)	A(3,0)	⋯	A(k,0)	⋯	A(m,0)
1	A(0,1)	A(1,1)	A(2,1)	A(3,1)	⋯	A(k,1)	⋯	A(m,1)
2	A(0,2)	A(1,2)	A(2,2)	A(3,2)	⋯	A(k,2)	⋯	A(m,2)
3	A(0,3)	A(1,3)	A(2,3)	A(3,3)	⋯	A(k,3)	⋯	A(m,3)
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
k	A(0,k)	A(1,k)	A(2,k)	A(3,k)	⋯	A(k,k)	⋯	A(m,k)
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
s	A(0,s)	A(1,s)	A(2,s)	A(3,s)	⋯	A(k,s)	⋯	A(m,s)

FIG. 36


START
S601
WOBBLING
S602
IN FOCUS AS A RESULT OF WOBBLING ?
S603
YES
NO
HILL - CLIMBING DRIVING IN DETERMINED DIRECTION
S604
PEAK PASSED ?
S605
NO
YES
RETURN TO PEAK
S606
PEAK REACHED ?
S607
NO
YES
STORE AF EVALUATION VALUE LEVEL
S608
ROUTINE FOR DETERMINING RESTART
S609
RESTART ?
S610
YES
NO
REMAIN STOPPED
S611